VOLUME 40 NUMBER 1 JULY, 1955

# AMERICAN JOURNAL OF OPHTHALMOLOGY

THIRD SERIES FOUNDED BY EDWARD JACKSON

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Publication office: 450 Ahnaip St., Menasha, Wisconsin

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*Subscription price in United States twelve dollars yearly. In Canada and foreign countries fourteen dollars.* Published monthly by the Ophthalmic Publishing Company. Subscription and Advertising Office: 664 North Michigan Avenue, Chicago 11, Illinois. Entered as second class matter at the post office at Menasha, Wisconsin. Printed in U.S.A.

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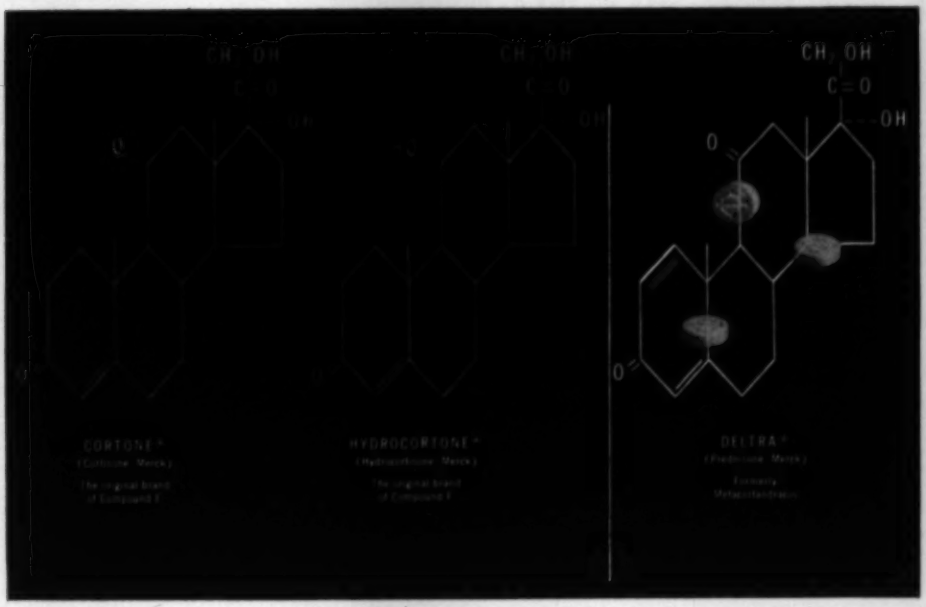


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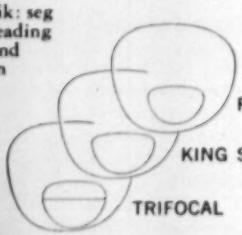


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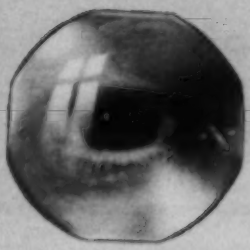

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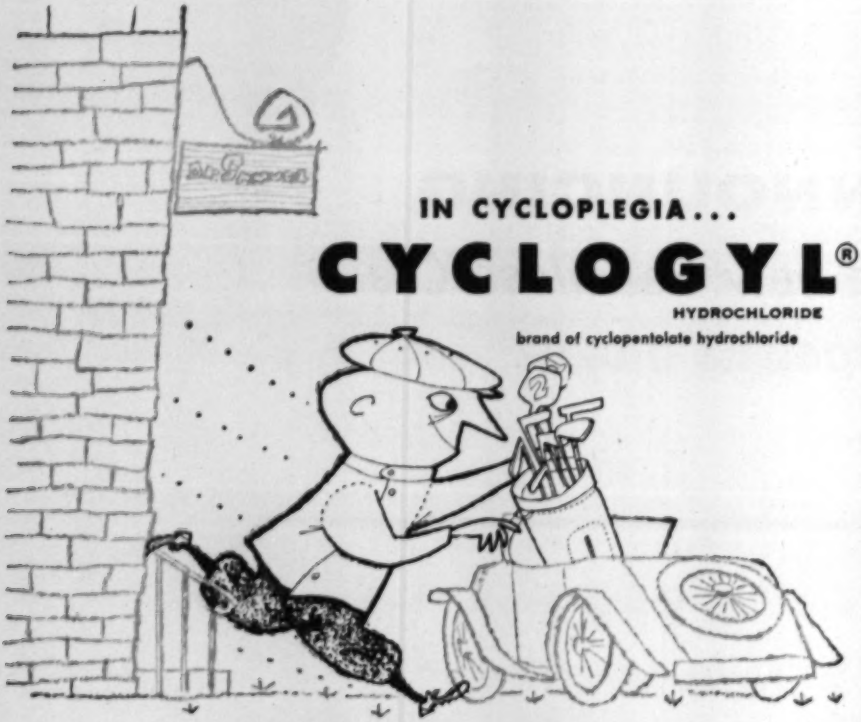

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*1. Gordon, D. M., and Ebrenberg, M. H.: Am. J. Ophth. 38:831 (Dec.) 1954.*

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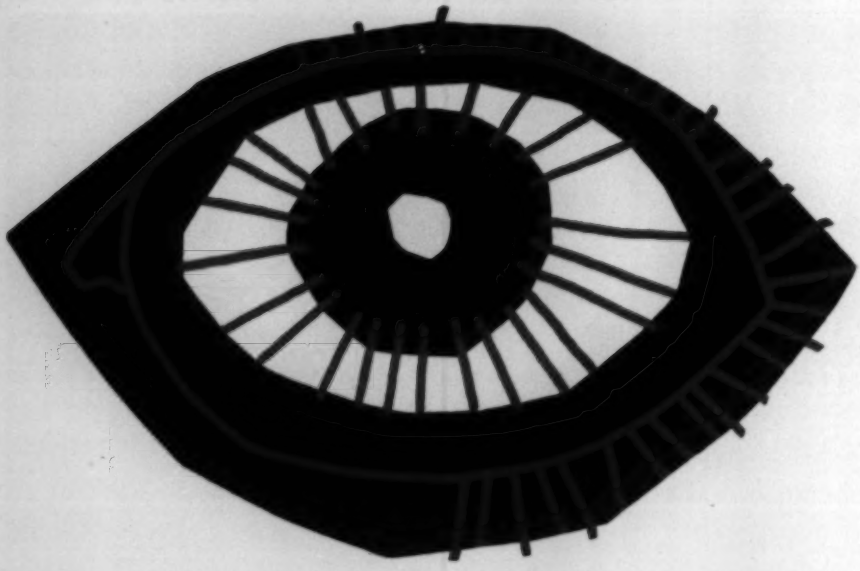

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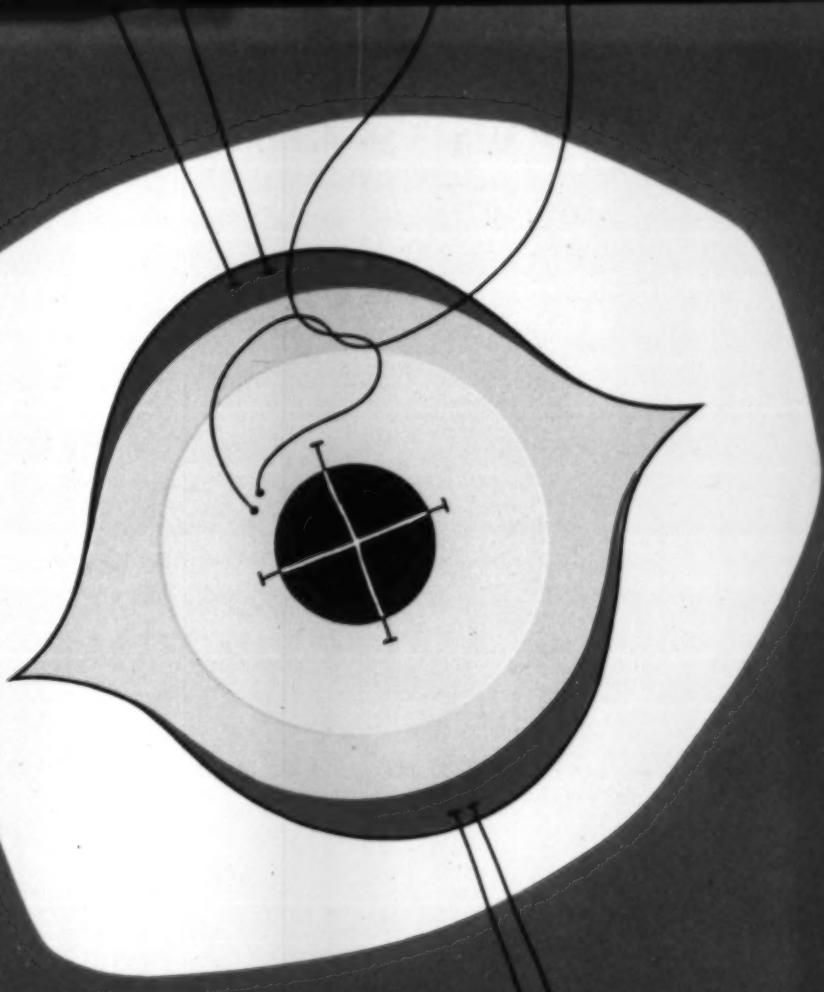

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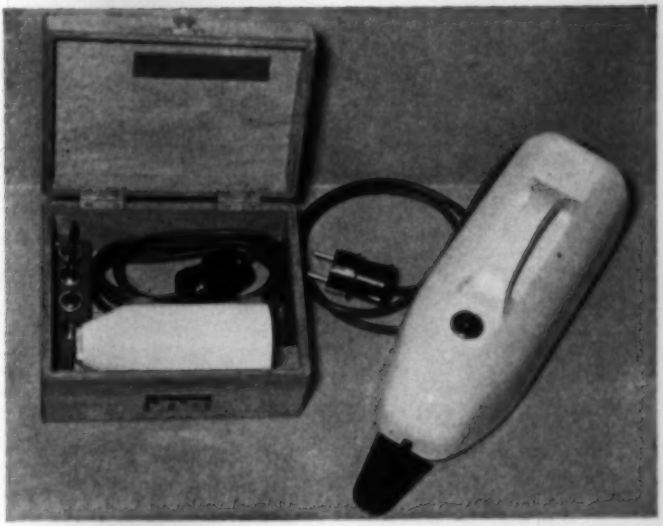

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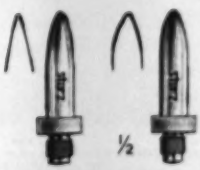

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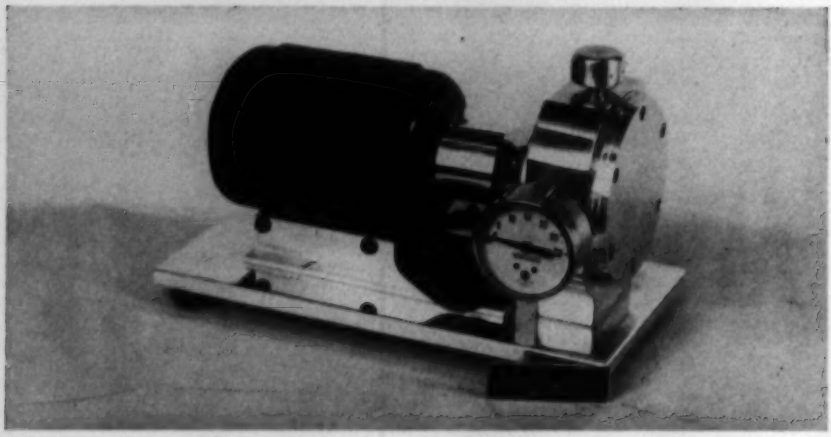

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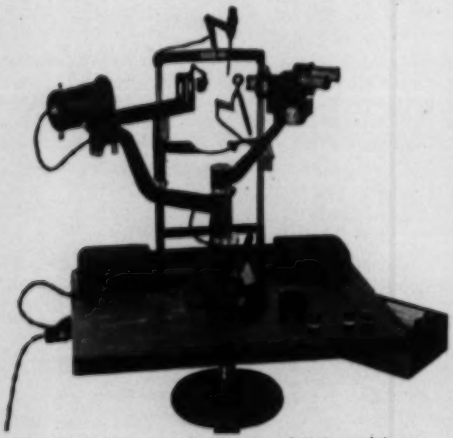

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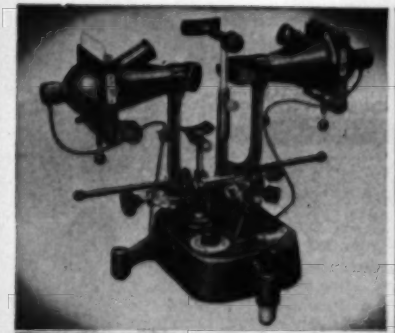

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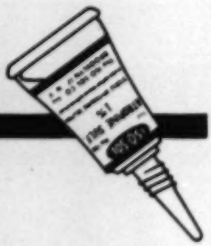

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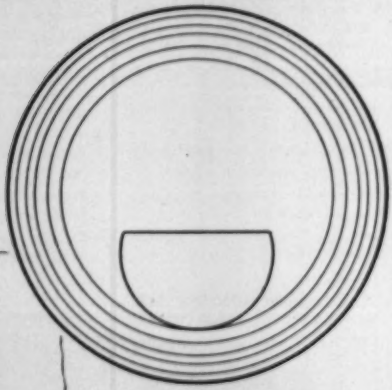

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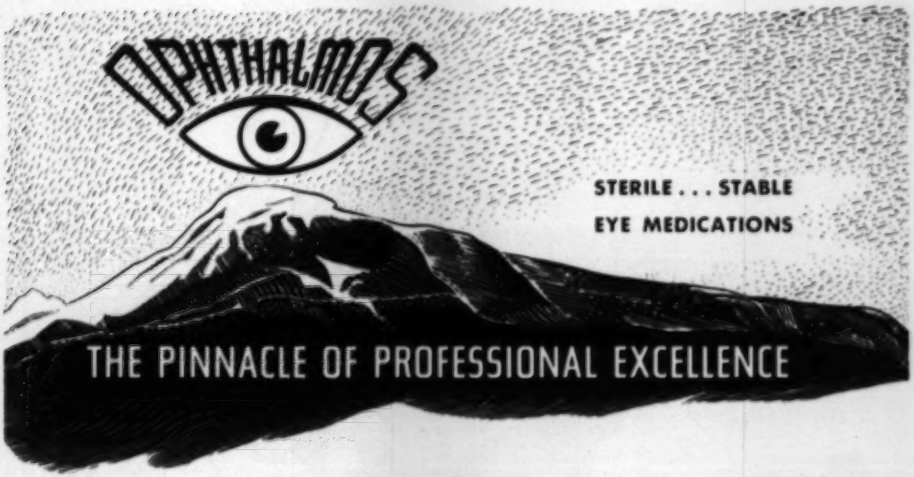


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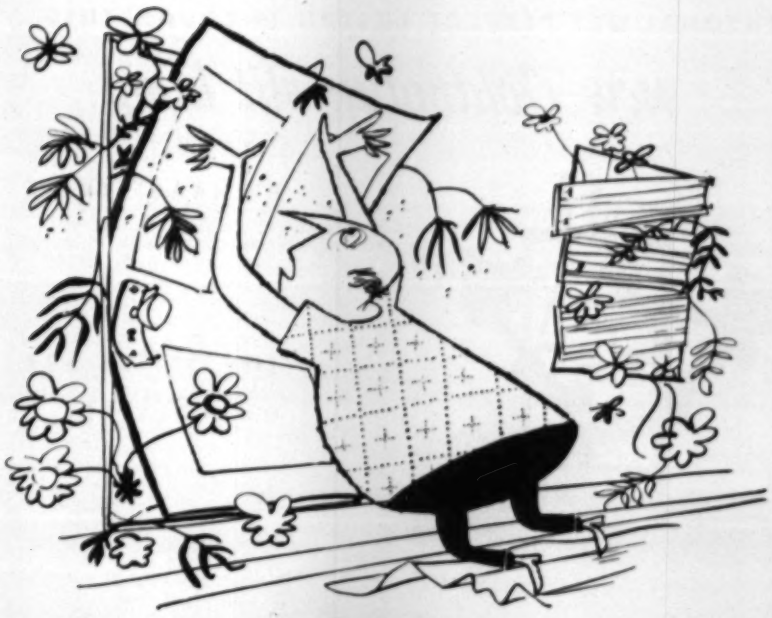

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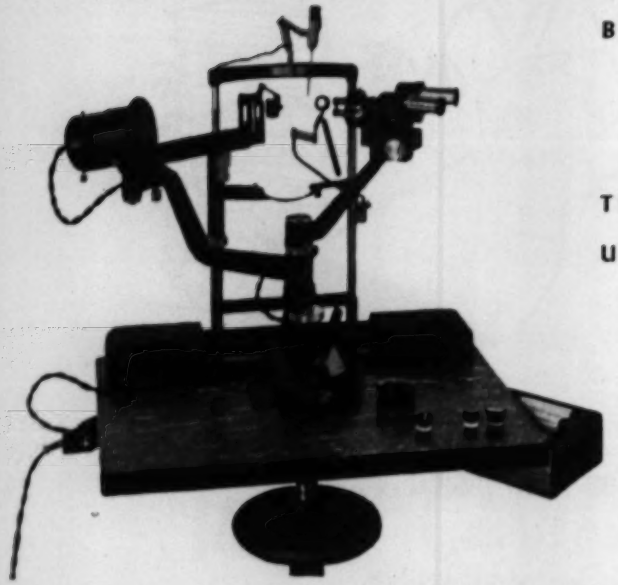

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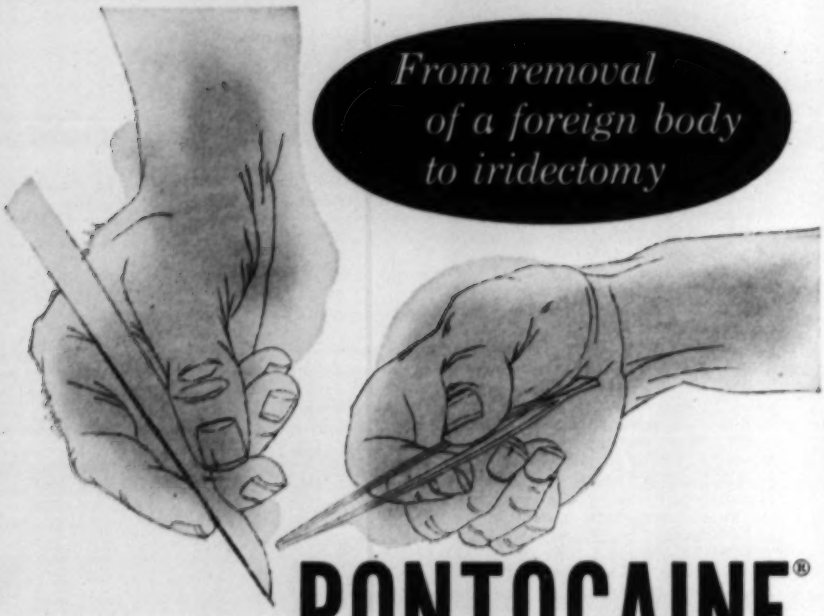


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VOLUME 40 JULY, 1955 NUMBER 1

# PATHOGENESIS OF CONGENITAL GLAUCOMA

## GONIOSCOPIC AND ANATOMIC OBSERVATION OF THE ANGLE OF THE ANTERIOR CHAMBER IN THE NORMAL EYE AND IN CONGENITAL GLAUCOMA

OTTO BARKAN, M.D.
*San Francisco, California*

Gonioscopic examination of the anterior chamber in vivo is free from the artefacts which are inherent in anatomic sections. To trace the development of the normal angle of the anterior chamber from infancy to adulthood more than 40 normal eyes of infants and children have been examined microgonioscopically. An attempt has been made to correlate the gonioscopic observations with the microscopic anatomic findings. A similar study of more than 150 eyes afflicted with congenital glaucoma is reported.

### METHOD OF EXAMINATION

In order to permit delicate focusing and obtain a high resolving power, gonioscopy is best performed with a binocular microscope (coated lenses) on an adjustable stand, a focal illuminator held in the hand, and a contact lens made of glass.[1-3] The total magnification is ×30. The patient is in the recumbent position. Infants and children are examined under intratracheal anesthesia. This method of examination provides for an accurate and detailed study.

### THE NORMAL ANGLE AND ITS CHANGES FROM INFANCY TO ADULT LIFE

In the normal eye in infant and child the iris inserts in a horizontal plane so that there is no angle recess as is seen in the adult eye. The angle is clothed by an almost transparent membrane with a shagreened surface which extends downward from the line of Schwalbe over the trabecular zone[2] (figs. 1 and 2). It covers the uveal meshwork, extends over the peripheral portion of the iris, and has been observed crossing a portion of a crypt as an isolated layer. It is assumed to represent the endothelium. Superficial circumferential fibers of the corneoscleral trabeculum can also usually be seen in the trabecular zone as first described by Salzmann.[4] From the level of the spur the shagreen drops in a more vertical plane over the uveal meshwork to the iris. The latter is picked up in small folds or tents. The line of insertion of the iris into the membrane meanders in the individual and varies in different eyes. It is often represented by a delicate irregular seam. A lacework of uveal tissue often extends into the membrane.

The shagreened membrane is so transparent in infancy that the iris can be seen through it continuing in a horizontal plane to its insertion into the ciliary zone of the angle wall. The scalloped ends of the pigment layer of the iris are seen to turn up slightly. In adults the shagreened surface is also present but the picking up of small folds and tents of iris is less marked. The tissues are less transparent.

The optic section of the angle in the infant is relatively larger than in the adult, indicating that the surface membrane is more axially situated as well as being more vertical. Because of this and the greater transparency of the tissues the three dimensional effect is remarkable in the infant. In the ensuing years the optic section becomes

Fig. 1 (Otto Barkan). Microgonioscopic view of angle in a normal eye of infant (aged eight weeks). (A) The ring of Schwalbe. (B) The iris can be seen through the transparent shagreened membrane proceeding horizontally to its insertion into the ciliary zone of the angle wall. (C) A lace-work of uveal tissue extends into the membrane.

narrower. The space between the shagreened membrane and the scleral wall may be optically empty or be crossed by numerous fibers of the uveal meshwork.

In the infant there is gonioscopically more uveal meshwork and there are more iris processes than in older children or adults. The processes largely occupy the angle, being arranged in tiers and frequently extending to the angle wall anterior to the spur. Many processes take their origin from a more axial position on the iris than is the case in older children and adults. In ensuing years the processes regress and fewer are seen in older children; residuals can occasionally be seen as stumps on the anterior surface of the iris or as flecks of pigment on the surface of the trabeculum. The gonioscopic appearance of the chamber angle in the normal infant thus suggests incomplete differentiation and regression of tissue and indicates that it is still developing.

In anatomic sections Seefelder and Wolfrum[12] reported rudimentary remnants of the pectinate ligament (uveal meshwork) as a consistent finding in a large number of newborn infants studied by them.

It has also been generally agreed, according to Salzmann, that an endothelium covers the anterior surface of the iris although microscopic descriptions of this layer differ greatly. In microscopic sections this layer

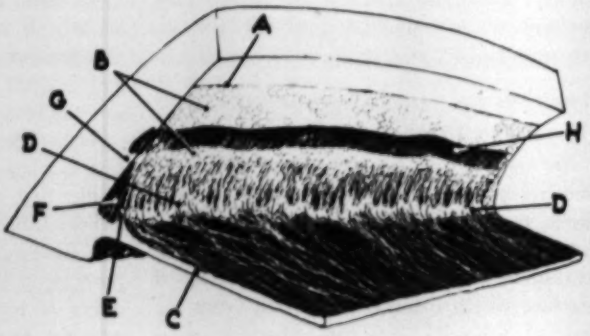


Fig. 2 (Otto Barkan). Drawing showing semischematically the microgonioscopic appearance of the angle in a normal eye of a five-month-old infant. (A) The ring of Schwalbe. (B) The shagreened surface or membrane extends downward from the ring of Schwalbe over the trabecular zone. (C) The plane of the iris is horizontal. (D) The line of insertion of the iris into the shagreened membrane. A lace-work of uveal tissue often extends into the membrane. (E) The hooklike process of Seefelder found in anatomic sections. (F) Meshwork traverses the angle. (G) Spur. (H) Schlemm's canal filled with blood.

continues over the angle and uveal meshwork. It appears to correspond to the shagreened membrane which is seen gonioscopically. In sections it is sometimes lost during preparation, fixation, and sectioning.

Occasionally, there are signs in anatomic sections of older children that iris processes which had previously traversed the angle have been torn off or have been obliquely sectioned. Troncoso[18] states, "In microscopic slides it is difficult to find the pectinate fibers, unless the section happens to be exactly in the meridian where the cord runs upward from the sinus. They are usually disposed in a row, but in some cases there are several deeper rows springing from the inner slope of the anterior concavity of the iris."

It is understandable that the transparent shagreened membrane which is seen gonioscopically and which probably consists of a layer of endothelial or other cells, or only slightly more than that, might easily be lost in the preparation of anatomic sections. In fact, it is so delicate that gonioscopically it appears to have escaped observation until recently.[2]

If in infants details are followed upward from the seamlike insertion of the iris it is seen that they lie on the surface of a membrane which is in an almost vertical plane. In the ensuing months fenestrations in the shagreened membrane are more frequent than in early infancy and as a result of regression of the tissue of the angle, the membrane later loses its verticality and becomes oblique. The membrane is not evident on casual gonioscopic examination with a slit-beam because of its transparency and the almost optically empty space behind it and because the beam is not reflected sufficiently to become visible until it has penetrated some distance behind the membrane. Consequently the optic section appears narrower and its internal contour more oblique than it is in actuality.

The shagreened membrane is easy to see in congenital glaucoma because it is more opaque.

In the nonglaucomatous infant or child Schlemm's canal usually fills with blood upon application of the contact glass (fig. 2). It can be seen lying immediately under the transparent shagreen which represents the surface of the normally permeable trabeculum. If the canal has not spontaneously filled with blood after application of the glass it can be made to fill promptly throughout its extent by exerting digital pressure on the jugular veins. This phenomenon,[4] which is so easily produced in infants and younger children, is difficult to elicit in adults,[5] and can be elicited with regularity only by paracentesis of the anterior chamber followed by jugular compression.[6]

The blood-filled Schlemm's plexus is usually wider in the infant than in the adult and because of the transparency of the tissues can be seen in exquisite detail.[7,8] It lies in a slightly oblique plane, the anterior edge being nearer the observer. It undulates and in places approaches the line of Schwalbe more closely than in others. Frequently it can be seen branching like a stream in a delta as depicted by Maggiore,[9] Theobald,[10] and Ashton.[11]

In the course of years the ciliary body broadens and its anterior surface comes to lie in a plane slightly deeper than that of the iris thus forming the angle recess or the rounded angle of the adult. The rounded adult form of the angle was explained by Seefelder and Wolfrum[12] by the growth of the circular portion of the ciliary muscle which in the newborn is rather flat but which continues to develop for a variable time after birth.[13]

Iwanoff[14] had earlier suggested that the general shape of the ciliary body depends largely upon the shape of the circular fibers.

According to Lange[15] the degree of development of the muscle depends in some degree upon the refractive power and the amount of work the muscle is called upon to perform.

Stieve[16] noted the widening and change in shape of the anterior end of the ciliary

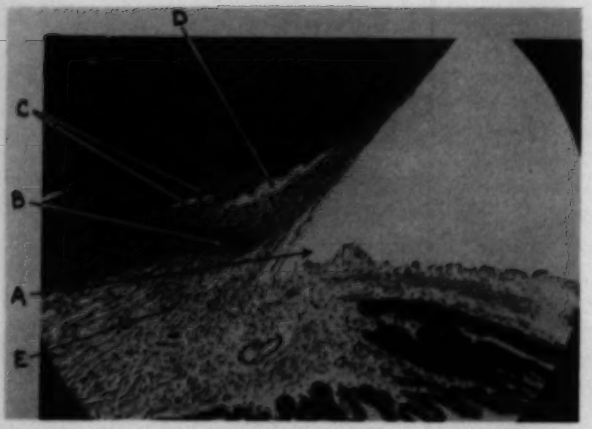


Fig. 3A (Otto Barkan). Anatomic section of normal angle of four-month-old infant. (A) Anterior chamber. (B) Scleral spur. (C) Anterior ciliary veins. (D) Schlemm's canal. (E) Narrow ciliary body.

muscle with age as well as the thickening of the connective tissue cap which covers the ciliary body.

A comparison of Figure 3A, an anatomic section of a four-month-old child, with Figure 3B, that of a 22-year-old man taken from Seefelder,[17] illustrates well the broadening of the anterior end of the ciliary body.

Individual differences in refraction and in the length and thickness of the root of the iris mentioned by Troncoso[18] and Busacca[19] also influence the configuration of the angle.

Anatomic sections, however, do not give a true picture of the topography of the angle because of displacements of the iris and other tissues. Gonioscopy shows that the configuration of the angle and its recess is influenced markedly by the direction taken in vivo by the root of the iris where it leaves the ciliary body. In infancy and youth the iris emerges in a horizontal plane (figs. 1 and 3A); in later life, depending upon various conditions, the root of the iris emerges in an arc, thereby encouraging the formation of a recess.

The physiologic seclusion and relative bombé of the iris which are present and may be marked in some adult eyes (shallow axial depth of the anterior chamber, hyperopia, small cornea)[20,21] are also important factors in influencing the shape of the angle recess.

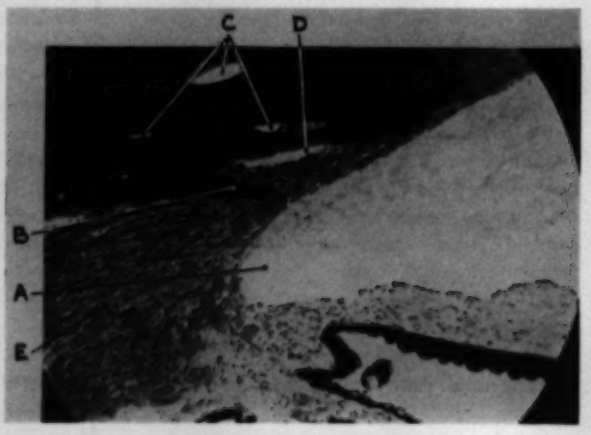


Fig. 3B (Otto Barkan). Anatomic section of normal angle of 22-year-old adult (Seefelder). (A) Anterior chamber. (B) Scleral spur. (C) Anterior ciliary veins. (D) Schlemm's canal. (E) Ciliary body broadened anteriorly. Note the rounded angle of the adult (angle recess).

### The angle and Schlemm's canal in congenital glaucoma

In the glaucomatous infant, as in the normal, gonioscopy shows that the plane of the iris is horizontal (fig. 4). The shagreened membrane covering the canal is less transparent than in the normal. It drops more or less vertically from the line of Schwalbe to the plane of the iris. In the area of Schlemm's zone the membrane appears to represent the anomalously differentiated trabeculum which crosses the angle in anatomic sections as shown in Figure 5. The folds or tents of uveal tissue which insert into the membrane (anomalous trabeculum) from the anterior surface of the iris are more definite and extend higher toward the line of Schwalbe (fig. 4). They appear to correspond to the hooklike processes described in anatomic sections by Seefelder (fig. 5). The tentlike insertions may cast a shadow on the angle wall. This should not be confused with the band of the ciliary body. In many cases the anterior insertion of the iris into the trabeculum partially or entirely covers the ciliary zone of the angle wall and hides it from view (figs. 4, 5, 6, and 7C). In some the insertion of the iris is so far anterior that only a narrow area of the trabecular zone can be seen.

Gonioscopically there is more tissue, or tissue which is more opaque, overlying Schlemm's canal as judged by the more subdued color and lesser definition of the blood-filled Schlemm's canal and by the thicker optical section[2,7] (fig. 7B). In contrast to the clear picture seen in the normal

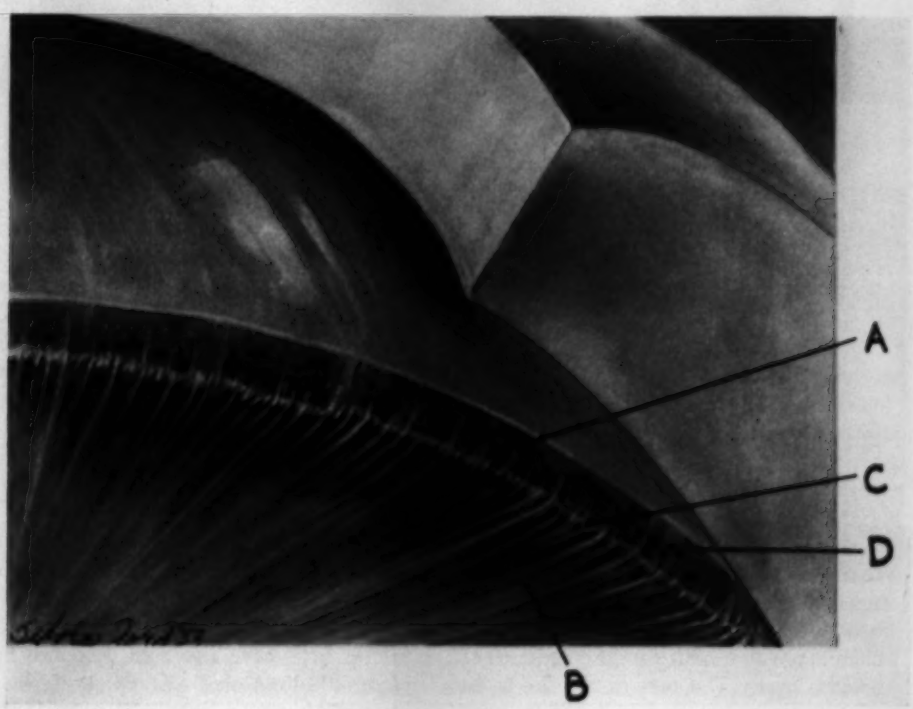


Fig. 4 (Otto Barkan). Microgonioscopic view of angle in a case of infantile glaucoma (age seven weeks). (A) Ring of Schwalbe. (B) The iris is shown proceeding horizontally to (C) its anterior insertion into the shagreened membrane which covers the thickened trabeculum. (D) The exposed area of trabeculum is somewhat opaque indicating diminished permeability.

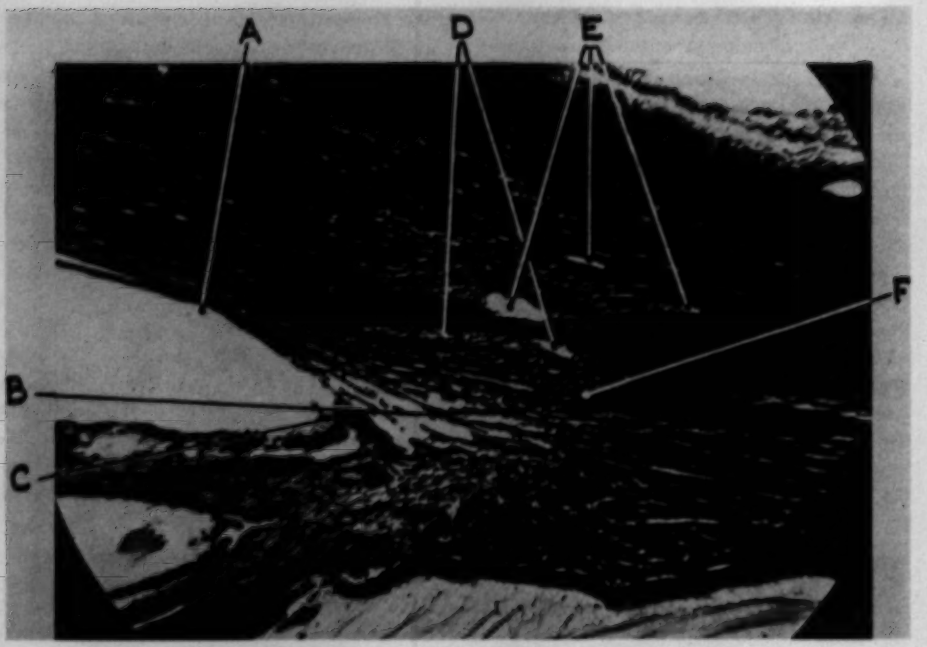


Fig. 5 (Otto Barkan). Section taken from Seefelder of the angle region in a seven-day-old infant with congenital glaucoma. (A) The ring of Schwalbe. (B) Shows the anomalously differentiated trabeculum. (C) At the anterior insertion of the iris is the hook formation described by Seefelder. This corresponds to the tentlike folds and the seamlike attachment seen in the gonioscopic picture. The oblique plane of the iris is considered to be an artefact since in vivo as seen gonioscopically the plane of the iris is horizontal. (D) Indicates the canal of Schlemm. (E) Represents collector channels. (F) Indicates the scleral spur.

infant's eye (fig. 7A), in congenital glaucoma the pink band representing the blood-filled Schlemm's canal is faint, being veiled by overlying tissue (figs. 7B and 7C), or the phenomenon cannot be elicited. In surgically controlled eyes it can almost always be elicited by jugular compression but is thinner and more irregular than in the normal, indicating that the canal is defective.

Seefelder[17] describes the histologic condition of the angle structures in infants with congenital glaucoma essentially as follows: There is an abnormal development of the trabeculum with insufficient differentiation of its outer layers. The root of the iris is inserted closer to the ring of Schwalbe than normal at the same time sending a thick hooklike process toward the end of Descemet's membrane. The potential chamber angle is crossed by the anomalously differentiated or abnormally persisting trabeculum. Schlemm's canal plexus is narrowed and partially obliterated. The area of access to the lumina of Schlemm's canal which are placed behind the actual free angle is, according to Seefelder, obstructed or narrowed by incomplete separation of the root of the iris from the posterior surface of the cornea. A similar interpretation was expressed by Collins.[22]

In my experience the gonioscopic picture (fig. 4) corresponds to the anatomic findings (fig. 5) and supports Seefelder's and Collins' pathogenic interpretation. Similar gonioscopic findings have also been described by Troncoso,[18] François,[23] Kluyskens,[24] Gallenga and Matteucci,[25] and Matteucci.[26]

I have been able to observe microgonioscopically signs of the physiologic regression of the uveal meshwork and its processes over the years in normal eyes. Presumably in

cases of congenital glaucoma in which the developmental anomaly in the angle is slight, a similar regression might result in improved outflow and thus in a spontaneous arrest of the glaucoma. This is, however, an exceptional occurrence. More commonly there is delayed onset or there may be aggravation of symptoms and pressure during the first months of life. This can be explained satisfactorily only through assuming an increased or changed secretion. What the role of the secretion-inhibiting drug, Diamox[29, 30] may prove to be in the future, only experience and prolonged observation will tell.

## Discussion

If it is assumed that the transparency of the trabeculum indicates its permeability, then it is frequently possible by means of microgonioscopy to estimate approximately the permeability of the tissue which overlies Schlemm's canal. The degree of obstruction can also be inferred from the presence or absence of other changes in the angle which indicate congenital glaucoma, especially the characteristic anterior insertion of the iris, the anomalously picked-up folds of the anterior stromal layer of the iris, and the exaggerated upturning of the scalloped ends of the pigment sectors.

Cases of successful goniotomy in which the pressure has been normalized by dividing the semitransparent membrane (the anomalously differentiated trabeculum) suggest that it is the relative impermeability of this structure which is the main cause of the retention (figs. 5, 6, and 7). The abnormal anterior insertion of the iris with which it

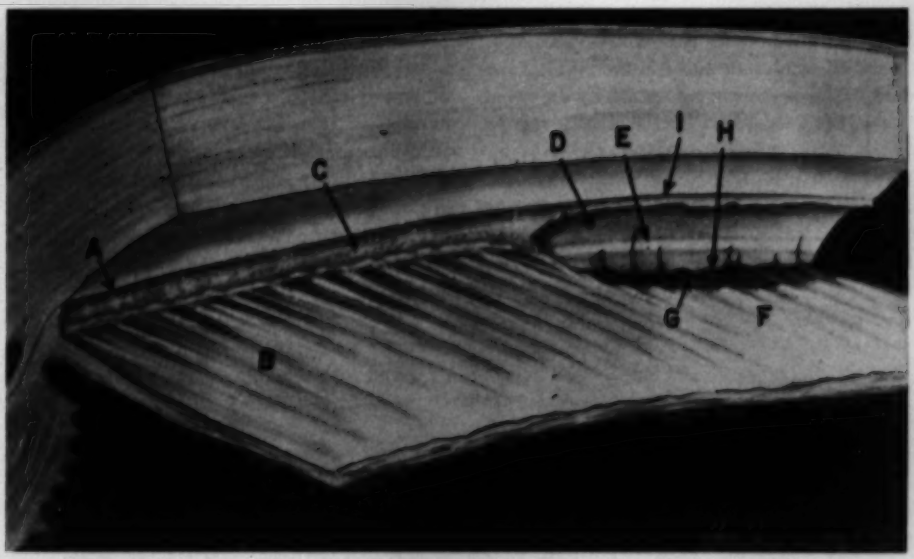


Fig. 6 (Otto Barkan). Drawing shows schematically the postoperative microgonioscopic appearance at the point of transition between the area on the right in which the angle has been operated and the neighboring untouched region. (A) Ring of Schwalbe. (B) The plane of the iris is horizontal. It inserts by means of a wavy line into a semitranslucent cellophanelike shagreened surface. This is the inner surface of the anomalously differentiated trabeculum which crosses the angle in anatomic sections as shown in Figure 5. (C) The cellophanelike shagreened surface membrane inserts into the ring of Schwalbe in an almost vertical plane. The width of this surface or membrane shows many variations according to the degree of anterior insertion of the iris. (D) Angle wall exposed. (E) Scleral spur. (F) Iris stroma, released and recessed from its attachment to the ring of Schwalbe. (G) The segments of pigment epithelium lie in a more posterior plane. (H) Insertion of iris to angle wall. (I) Note ring of Schwalbe curving slightly upward in the region in which the attachment of the iris has been separated from it. (The cross section on the left of the drawing is a schematic representation of anatomic sections.)

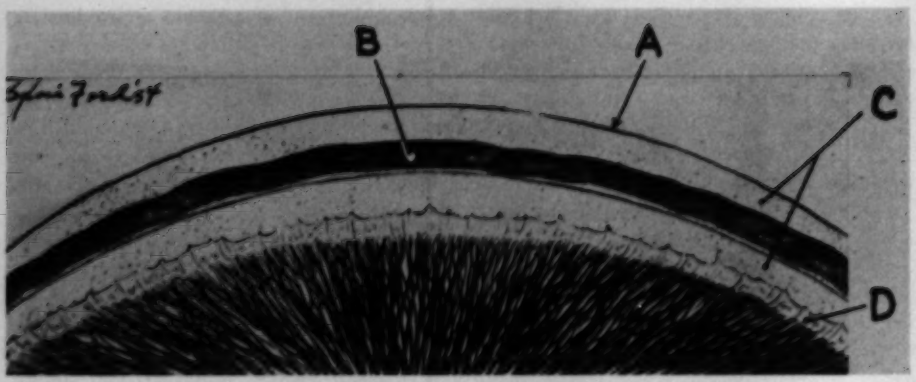


Fig. 7A (Otto Barkan). Drawing representing gonioscopic view of normal infant angle showing transparency of tissue overlying the blood-filled Schlemm's canal. (A) Ring of Schwalbe. (B) Blood-filled Schlemm's canal. (C) Shagreened membrane overlying the canal. (D) Tentlike wavy insertion of iris tissue into the membrane.

is frequently combined may, by diminishing the area of outflow, be a contributing factor.

It is difficult to determine whether the posterior position of Schlemm's canal relative to the apparent angle is the result of an actual fetal posterior placement of the canal, as has been suggested, or is merely relative to the anterior insertion of the iris. It appears evident both gonioscopically and histologically that there is an anterior insertion of the iris in many cases (figs. 5, 6, and 7). This is supported by what is seen at goniotomy when, immediately the incision is made, the iris drops backward as if it had been pulled or pinned up toward the ring of Schwalbe. In addition, gonioscopically, a blood-filled Schlemm's canal, albeit often defective, can be seen in the exposed area in most cases in which goniotomy has successfully normalized pressure which suggests that it is not posteriorly placed in actuality but only appears so relative to the anterior insertion of the iris.

On the basis of histologic sections of late

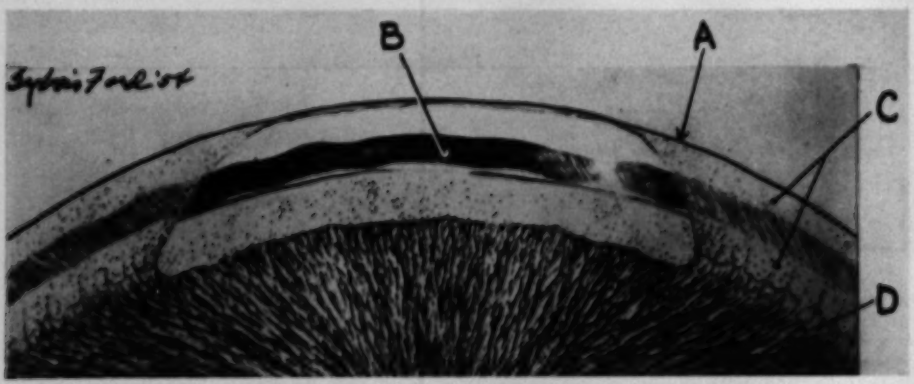


Fig. 7B (Otto Barkan). Gonioscopic view of angle in a case of infantile glaucoma (age three months) after operation by goniotomy. (A) Ring of Schwalbe. (B) Blood-filled Schlemm's canal. (C) Shagreened membrane overlying the canal is more opaque than normal. In this case the insertion of the iris is normal. The trabeculum veiling Schlemm's canal is less transparent than normal. Its incision has exposed Schlemm's canal to aqueous.

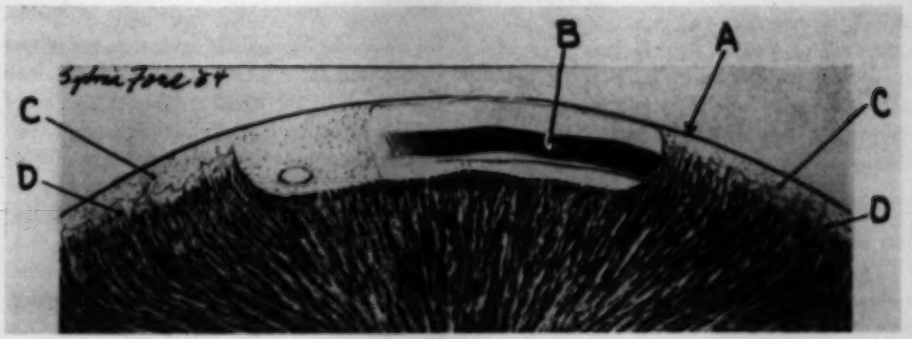


Fig. 7C (Otto Barkan). Gonioscopic view of angle in a case of infantile glaucoma (age four months) after operation by goniotomy. (A) Ring of Schwalbe. (B) Blood-filled Schlemm's canal. (C) Shagreened membrane. (D) Anterior insertion of iris into membrane. In the unoperated area the anterior insertion of the iris hides Schlemm's canal from view. After incision near the line of Schwalbe the iris has dropped back exposing Schlemm's canal to aqueous. In the left-hand side of the incised area some of the veiling tissue (anomalous trabeculum) is still present.

cases it has been presumed, in the past, that Schlemm's canal is frequently absent in congenital glaucoma. Re-examination of more than 40 eyes in which the tension had been normalized by goniotomy in infancy revealed that in those cases in which the canal did not fill with blood spontaneously it could be made to fill by digital pressure on the jugular veins as suggested by Scheie in all but two. In these eyes the tension had been normalized by operation performed between the ages of one and six months. It may be that if aqueous had not been given access to the canal at this early age it would have collapsed and atrophied from lack of function and as the result of increasing distention. This would explain its absence in many anatomic sections obtained at a later age. The fact that pressure can be normalized by goniotomy in infancy in 80 percent of eyes is indication of the presence and functional adequacy of the Schlemm's canal mechanism.

Meller[27] called attention to the possibility of collapse from functional inactivity when he noted rows of endothelial cells without sign of a lumen in microscopic sections in the location of Schlemm's canal.

Anderson[28] noted that the marked variation in frequency of the presence of Schlemm's canal in anatomic sections reported by different observers depended largely on the age of the specimens examined. In early cases the canal was present in 70 percent of cases, whereas no sign of it was found in well over half of the specimens which were obtained after the age of two and one-half years.

Anderson's analysis supports the view that the canal becomes closed as a secondary process. His suggestion is confirmed by the postoperative gonioscopic finding of a blood-filled Schlemm's canal in successfully operated cases of infantile glaucoma, indicating that the canal is almost always present at birth. However, on the basis of both its gonioscopic and anatomic appearance, the canal is probably defective in many cases. Successful results of goniotomy up to the age of seven years in cases of congenital glaucoma of delayed onset in which but little distention has taken place indicates that under these conditions Schlemm's canal remains patent.

Meller's observation in anatomic sections of the absence of crypts in the iris in congenital glaucoma is supported by the microgonioscopic findings in the present series in which a striking feature was the frequently almost amorphous velvety appearance of the anterior surface of the iris. What the func-

tional connotations of this change in the structure of the iris may be it is impossible to say at the present time. It is frequently associated with impermeability of the trabeculum and appears to be developmentally related to it.

### The importance of early operation by goniotomy

The results of goniotomy indicate that although the Schlemm's canal outflow system frequently appears defective both by gonioscopy and in anatomic sections it is nevertheless functionally effective in most cases. To explain this apparent paradox it is suggested that the physiologic reserve of the Schlemm's canal mechanism is so great that in the presence of an anatomically defective mechanism aqueous can yet escape in sufficient quantity to maintain normal pressure provided aqueous is given access to it. For this reason and to prevent further distention the urgent need of early diagnosis and early goniotomy is stressed.

An even more important reason for early operation is the urgent need of reversing the corneal cloudiness thereby permitting the development of visual acuity, preventing amblyopia and assuring attainment of excellent ultimate visual results.[2, 7]

### Conclusions

The gonioscopic findings in the normal angle have been traced from infancy through adult life and have been found to correspond to the microscopic anatomic findings.

Gonioscopically a transparent membrane has been observed which has a shagreened surface and clothes the angle, extending downward from the line of Schwalbe over the trabeculum and the uveal meshwork. In infants its plane is vertical. It is assumed to represent the endothelium.

In older children the optic section extending from the shagreened surface to the scleral wall gradually diminishes in size along with regression of the uveal meshwork and takes on the conformation of the adult angle.

The configuration of the adult angle is influenced by functional factors, such as relative seclusion of the pupil with iris bombé, as well as by anatomic factors.

A prominent blood-filled Schlemm's canal is readily seen in all normal infants upon application of the contact glass. In adults it is more difficult to elicit and is relatively smaller in size. In congenital glaucoma the canal is not easily observed except in eyes in which the pressure has been normalized and the obstructive tissue hiding it has been severed by goniotomy. It is frequently found anatomically defective though functionally adequate to normalize pressure.

Evaluation of the gonioscopic findings in congenital glaucoma before and after goniotomy shows the anomalously differentiated trabeculum to be less permeable than in the normal eye, as has been assumed from histologic studies.

Gonioscopy and the results of goniotomy show that Schlemm's canal is initially present, albeit often defective, in most cases of congenital glaucoma. It can become functionally effective provided that aqueous is given access to it at an early stage. The structures in the angle in congenital glaucoma are thus related to the disturbance of function and to the action of goniotomy.

The urgent need of early diagnosis and early goniotomy is stressed from the anatomic point of view. Early operation is imperative also from the functional point of view in order to reverse the corneal cloudiness and encourage the development of visual acuity.

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# EQUATORIAL SCLERAL STAPHYLOMA

## Surgical treatment in a case with retinal detachment

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As far as could be determined very few cases of equatorial scleral staphyloma with retinal detachment are reported in the literature. These have been reported by Derrick Vail.[1-4] None of the cases has been treated by the method described in this article.

### Case report

A 57-year-old white woman was first seen February 22, 1954, complaining that three days previously she began to have flashes of light in the left upper field of the left eye. Two days previously she noted blurred vision and loss of the upper field. When questioned specifically she recalled that on February 18, 1954, she had fallen on the street and skinned her knee. Past eye history was negative except for slight nearsightedness and presbyopia. Past general history was noncontributory except for a coronary occlusion suffered in July, 1953.

*Eye examination.* Uncorrected vision was: R.E., 20/110; L.E., 20/300. With correction: R.E., 20/20+3; L.E., not improved. Ophthalmoscopic examination revealed a retinal detachment involving about three fifths of the retina. There was a large bulla in each of the lower quadrants and an extensive flat detachment of the upper temporal quadrant. The bullae were elevated 16 diopters. The macula was detached. There was an extensive vertical fold in the detached retina temporally which was thought to represent the previous limit of a long-standing peripheral retinal detachment. The visual field was very small.

The patient was hospitalized, the affected eye atropinized, binocular dressings applied, and complete bedrest was maintained.

The retina was studied often and at great length by both direct and binocular indirect methods. No holes were found. The superior temporal quadrant received more attention than other areas. At one time, after prolonged search in this area with the aid of scleral depression, the eye externally showed some swelling and hyperemia in this quadrant. At the time these changes were attributed to trauma. After three days of bedrest, the retinal elevation subsided considerably.

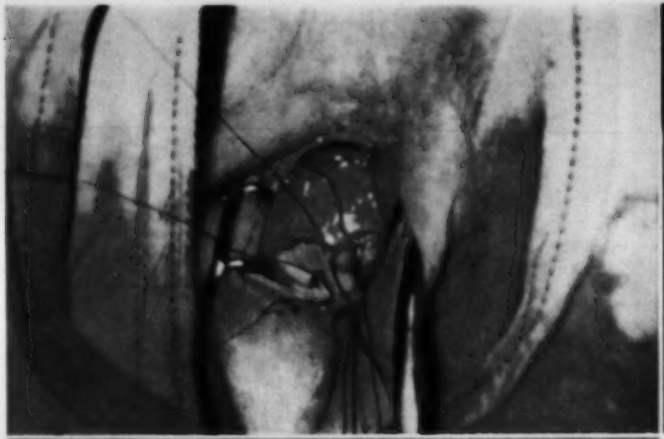
### Operation

On February 25th, under local anesthesia, the sclera of the three involved quadrants was laid bare using three separate sections. As soon as the sclera of the superior temporal quadrant was examined a large equatorial scleral staphyloma was evident. It was about 7.0 by 9.0 mm. in size.

Figure 1 shows only about one half of the lesion, the rest being hidden by the upper lid. The entire staphyloma seemed very thin and it merged abruptly into what appeared to be a sclera of normal thickness. It extended to within one mm. of the lateral aspect of the insertion of the superior rectus. When transilluminated, the light passed much more readily through the lesion than through the normal sclera.

It was decided that no operation was likely to succeed unless the localized increase in the volume of the globe could be permanently reduced. Due to the size of the lesion, the method of complete excision as practiced by Vail seemed too risky. Lamellar resection of the area did not seem indicated because the involved sclera was already extremely thin. It was decided to buckle the staphyloma inward and to treat the detachment with diathermy.

Accordingly, the two temporal conjunctival sections were made one. The lateral rectus was tenotomized and a lateral can-



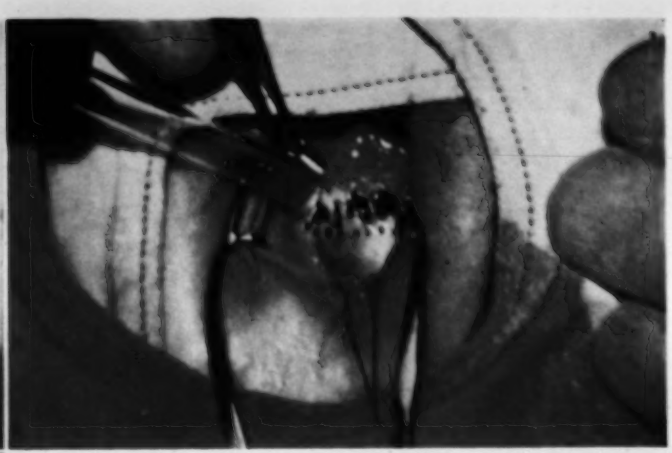


**Fig. 1 (above left), Fig. 2 (above right), Fig. 3 (lower left)**

Figs. 1, 2, and 3 (Young). Equatorial scleral staphyloma: Surgical treatment in a case with retinal detachment. (Fig. 1) Showing about one half of the staphyloma with some of the 6-0 sutures in place. One suture has been tied. (Fig. 2) Taken after the sutures had been tied. The blood-tinged subretinal fluid was aspirated from a point more posterior but the "sucker" slipped forward when the eye was placed in position for the photograph. Note the diathermy marks. The dark area of sclera is the portion normally under the lateral rectus. The stump of the external rectus is in the forceps. Approximately three times the visible amount of subretinal fluid was removed by aspiration. (Fig. 3) Showing the staphyloma in the right eye when the eye is rotated strongly inward and downward.

thotomy was done. Nonpenetrating diathermy applications were made in the sclera over the involved quadrants. These applications were made no closer than eight mm. to the limbus and extended about three mm. behind the equator. The staphyloma and the area around it were avoided. There seemed to be no elevation of intraocular pressure from these applications.

About seven deeply inserted mattress sutures of 6-0 silk were so placed as to turn in a spindle-shaped area of sclera including the staphyloma (6-0 silk was selected because the needles on the available 4-0 were too heavy to permit easy insertion). After tying the suture at each end, it was obvious that a larger thread would be required, therefore the remaining untied stitches were removed and the 4-0 silk was then easily threaded through the same tracts.

A penetrating diathermy application was made in one of the lower quadrants. Considerable subretinal fluid was removed to allow several of the stitches to be pulled up and tied. Twice more subretinal fluid in large amounts was removed from different areas to permit the rest of the sutures to be tied. Intraocular pressure was watched closely and at no time was it elevated.

One row of nonpenetrating diathermy was then applied anterior and posterior to the line of sutures. Figure 2 shows the appearance at this stage.

At this time, without discernible hardening of the eye, and while the eye was undergoing no manipulation, a small bead of solid vitreous appeared near one of the suture tracts. The bead spontaneously enlarged until a moderate amount of vitreous was lost. Apparently two adjacent, deeply placed, and tightly tied sutures had torn the intervening sclera with resultant rupture of choroid and retina, allowing the vitreous to escape.

Additional diathermy applications were made around the pinpoint hole from which the vitreous had escaped. The lateral rectus was reattached and the conjunctiva and Tenon's capsule closed.

POSTOPERATIVE COURSE

*Third day.* Cornea showed a moderately severe haziness and the anterior chamber was quite deep.

*Fourth day.* Corneal haze remained. Anterior chamber not excessively deep.

*Sixth day.* Cornea was much cleared. Descemet's membrane wrinkled.

*Ninth day.* Retina seemed to be in place throughout.

*Tenth day.* Folds in Descemet's persisted faintly.

*Fifteenth day.* Confrontation field normal.

*Twenty-seventh day.* Vision, O.S., 14/24.5. Discharged from hospital.

*Forty-eighth day.* Uncorrected vision: L.E., 20/60; with a $-1.0$D. sph. $\bigcirc$ $-0.75$D. cyl. ax. $90° = 20/40-2$. Ophthalmoscopy showed the retina to be everywhere in place. In the midperiphery of the upper temporal quadrant was a small triangular-shaped white area of sclera. Extending down from it was a straight sharp line indicating the site of the buckle. Round diathermy marks were visible on either side of the line. Beyond this line there was a diffuse area of pigment dispersion and choroidal reaction.

Postoperatively a full field was regained and maintained. When last seen, six months after surgery, vision with correction, left eye, was $20/30-3$. Ophthalmoscopy revealed the macula to be granular and the adhesive chorioretinitis to be inactive.

During the last two weeks of her hospital stay, the patient became disturbed by flashes of light in the unoperated eye. Later it was found that she had a large equatorial scleral staphyloma corresponding in size, shape, and location to the lesion in the operated eye (fig. 3). By ophthalmoscopy the retina under the staphyloma was seven diopters more remote than the corresponding area of retina of the lower nasal quadrant. The flashes of light persist, but there has been no detachment.

The postoperative correction for best vision in the left eye is practically the same as the correction worn preoperatively. The

keratometer revealed no unusual corneal astigmatism postoperatively. From these findings it would seem that no permanent alteration of corneal astigmatism or in the total refraction of the eye resulted from the surgery. There has been a slight, persistent flattening in the contour of the globe in the area of the buckling.

## Comment

In discussing Vail's paper, Reese[5] and Kirby[6] advocate that smaller staphylomas be treated with diathermy alone; but in the same discussion, MacDonald[7] reported one case of a larger lesion where this method failed.

Vail[3] used diathermy alone in two cases of large staphyloma and concluded that, unless the lesion is small, the method offers the least chance for success. He treated six cases with scleral resection modified after Müller, combined with diathermy. The remaining two cases he treated by passing sutures directly through the base of the lesion, tying the sutures to create a tuck, then excising the tucked portion and surrounding the area with diathermy.

Pischel[8] does not advocate the buckling operation for detachments in general. Where a radical operation seems indicated for cases with retinal shortage or vitreous strands, he prefers a lamellar scleral resection, leaving behind a very thin scleral lamella. At present he is not completely convinced that a lamellar is superior to a through and through resection of the sclera. His objection to buckling is that the operation creates an internal fold of sclera which can actually prevent the hole in the retina from reattaching to the exudate in the choroid and thereby being sealed off.

It seems that Pischel's objection to buckling does not apply to the case herein described and presumably need not apply to similar cases. The staphyloma, instead of buckling inward in one large fold, was thrown into many smaller folds like the side of an accordion. Ophthalmoscopic examination postoperatively showed no objectionably large internal fold such as Pischel has found after buckling normal sclera.

Vitreous loss in this case could probably have been avoided by using the mattress suture of Lindner[9] who also suggested the method of scleral folding for shortening the globe in retinal detachment.[9]

## Conclusion

A case of retinal detachment associated with a large equatorial scleral staphyloma is reported. The treatment by buckling inward a spindle-shaped area of sclera containing the staphyloma and application of scleral diathermy is described. A similar staphyloma but no detachment is present in the corresponding area of the fellow eye. A favorable outcome is present after a seven-month follow-up.*

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Grateful acknowledgment is made to James B. Hutcheson, M.D., pathologist, Lewis-Gale Hospital, who took the operative photographs.

* When the patient was heard from 14 months after surgery, no further visual difficulties had developed.

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# THE PATHOLOGY OF EXPULSIVE HEMORRHAGE*

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Expulsive hemorrhage has not enjoyed much attention in ophthalmologic literature during the last 20 years. This lack of interest probably explains why our knowledge of the pathogenesis of this most serious complication of intraocular operations has increased so little.

Only a few investigators have tried to solve this problem by means of anatomic examinations. In 1942,[1] I could refer to only 11 anatomic investigations and, since then, no anatomic studies have appeared except for an article by myself in 1945.[2] At that time I described the anatomic findings in six cases of expulsive hemorrhage.

The hemorrhage originated in five of the six eyes from a ruptured necrotic posterior ciliary artery. In the sixth eye a choroid artery was found which was largely dilated and obliterated by sclerosis and thrombosis; no ruptured artery, however, could be found. The clinical and anatomic data of these six cases were described in detail. Figures 1 through 5 represent a picture of the ruptured posterior ciliary arteries in five cases. Figure 6 represents the obliterated choroid artery in the sixth eye.

Five of these six eyes had suffered from a serious form of glaucoma, and the conclusion was drawn that glaucoma is able to cause vascular necrosis, especially in the posterior ciliary arteries. One of the arguments in favor of this view is provided by a disease which is closely allied to the expulsive hemorrhage, namely the *spontaneous rupture of the globe*. Such a rupture only occurs in glaucomatous eyes (Meller[3]), and the rupture is caused by a large subchoroidal hemorrhage. It is known that such a hemorrhage often occurs in glaucomatous eyes after a perforation of a corneal ulcer; an occurrence which is perfectly comparable to an expulsive hemorrhage after an intraocular operation.

Much more important, however, is the question why such a large subchoroidal hemorrhage can occur spontaneously in glaucomatous eyes, and why it never occurs spontaneously in nonglaucomatous eyes. In glaucomatous eyes the difference between the intravascular and the extravascular pressure is much smaller than in nonglaucomatous eyes; thus a rupture of the vascular wall is more likely to be expected in nonglaucomatous eyes. Therefore, another factor to induce subchoroidal hemorrhages must be present in glaucomatous eyes. According to my experience this factor must be a degenerated wall of one or more of the posterior ciliary arteries. Indeed Gräfenberg[4] has described a ruptured posterior ciliary artery as the cause of a spontaneous hemophthalmos in glaucoma.

Samuels[5] described eight cases of postoperative nonexpulsive subchoroidal hemorrhage in glaucomatous eyes, due to a rupture in one or both long posterior ciliary arteries. Samuels, however, thought that the arteriolar degeneration developed after the occurrence of the hemorrhage. Three of my cases in which the eye was enucleated immediately after the occurrence of the hemorrhage prove that the degeneration of the vessel wall is present before the onset of the hemorrhage.

In recent years I had the opportunity to study anatomically four other eyes with an expulsive hemorrhage after an intraocular operation. It appeared from the study of these cases that glaucoma is only one of the factors responsible for the occurrence of an expulsive hemorrhage.

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* This paper was read in abstract form before the XVII International Congress of Ophthalmology New York, 1954.

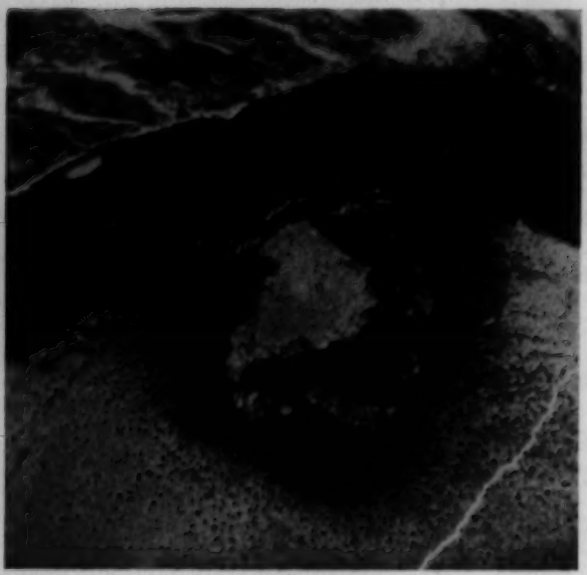


Fig. 1 (Manschot). *Case 1* (P.A. 1217, Amsterdam). Necrosis of short posterior ciliary artery. (van Gieson, ×56.)

CASE 7

A. S., a man, aged 85 years, developed an expulsive hemorrhage during the fifth day after an intracapsular lens extraction. Enucleation was performed one hour later. No history or signs of glaucoma were mentioned in the clinical history. The blood pressure was extremely low: the systolic pressure was 120 mm. Hg, and the diastolic pressure was 50 mm. Hg. The urine contained a trace of albumin and no glucose. The sediment showed no abnormalities.

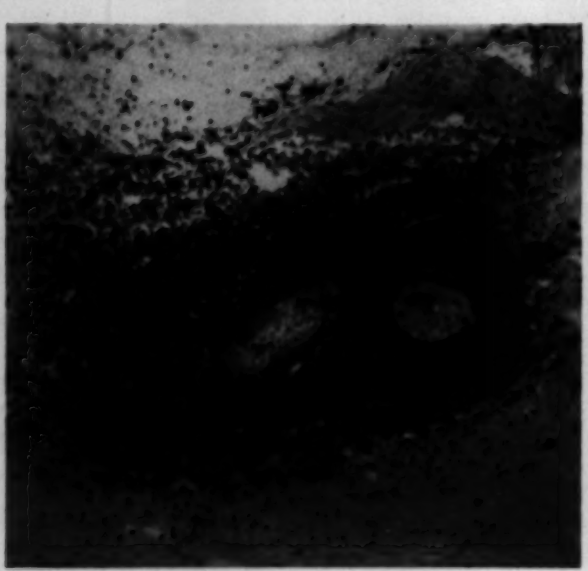


Fig. 2 (Manschot). *Case 2* (Str. 1703, Amsterdam). Necrosis of long posterior ciliary artery. (Hematoxylin-eosin, ×62.)

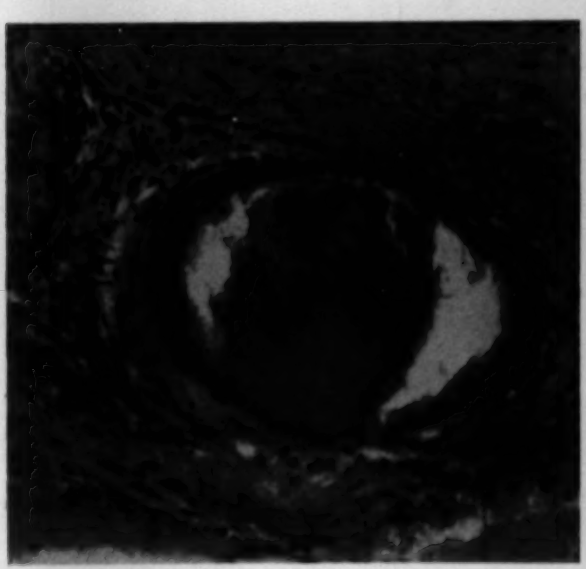


Fig. 3 (Manschot). *Case 3* (P.A. 1437, Amsterdam). Necrosis of long posterior ciliary artery. (Hematoxylin-eosin, ×265.)

*Anatomic examination* (P.A. 134) showed a large subchoroidal hemorrhage which filled the lumen of the eye. Two ruptured necrotic short posterior ciliary arteries were found (fig. 7); the ruptured elastic fibers were clearly visible. The long posterior ciliary arteries were unimpaired. A marked sclerosis of choroidal and retinal arterioles was present. No signs of glaucoma could be found.

CASE 8

J. de M., a woman, aged 70 years, developed an expulsive hemorrhage during the first evening after an extracapsular lens

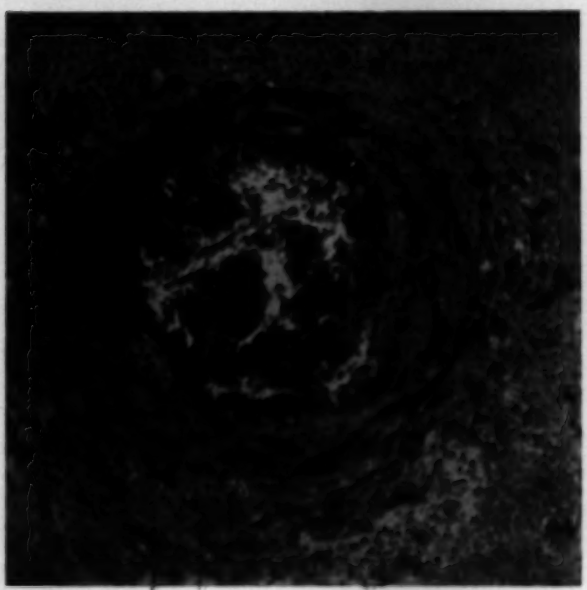
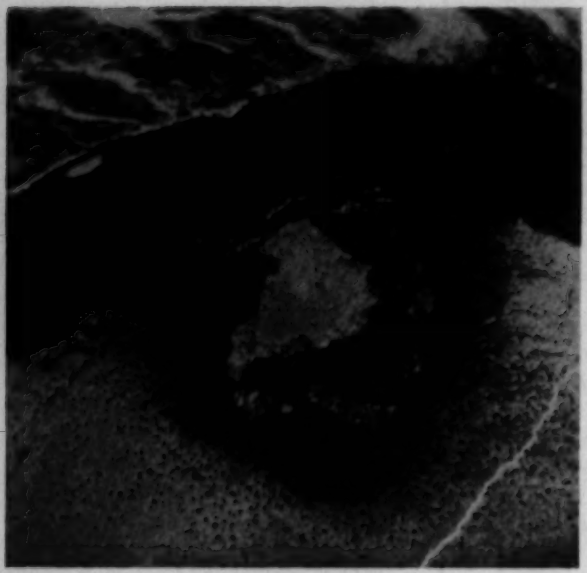


Fig. 4 (Manschot). *Case 4* (Str. 2247, Amsterdam). Necrosis of short posterior ciliary artery. (Hematoxylin-orcein, ×260.)



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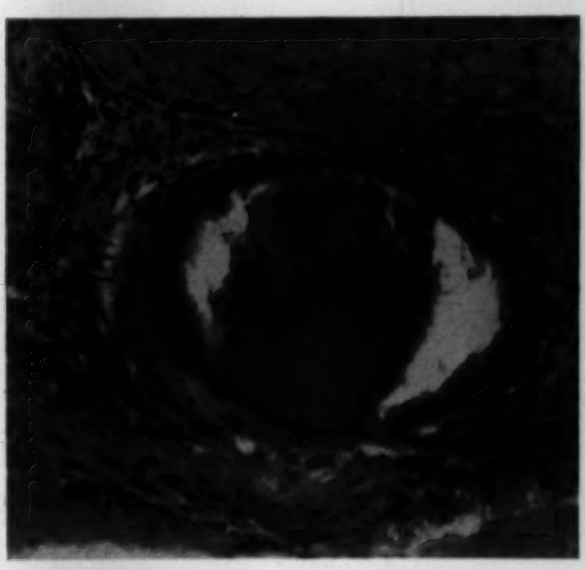

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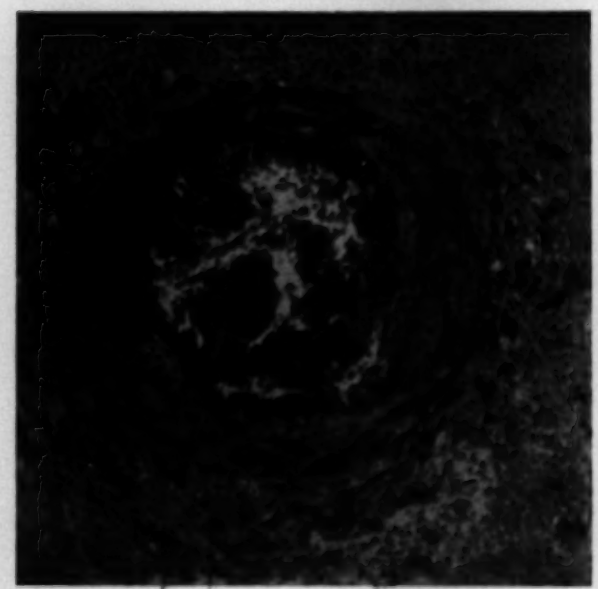

Fig. 4 (Manschot). *Case 4* (Str. 2247, Amsterdam). Necrosis of short posterior ciliary artery. (Hematoxylin-orcein, ×260.)

Fig. 5 (Manschot). *Case 5* (P.A. 1405, Amsterdam). Necrosis of long posterior ciliary artery. (van Gieson-elastin, ×205.)

extraction. Enucleation was performed four days later. The systolic and the diastolic blood pressure were, respectively, 200 mm. Hg and 110 mm. Hg. The urine contained no albumin or glucose; the sediment showed no abnormalities. No glaucomatous symptoms were found.

*Anatomic examination* (P.A. 65) revealed the typical picture of a subchoroidal hemorrhage which filled the whole eye. Two short necrotic posterior ciliary arteries were ruptured (fig. 8); a third one showed an aneurysmic dilation of its necrotic wall. A marked arteriolar sclerosis of the choroid was present. No symptoms of glaucoma could be found.

Fig. 6 (Manschot). *Case 6* (Str. 2283, Amsterdam). Thrombosis in necrotic choroid artery. (van Gieson, ×90.)

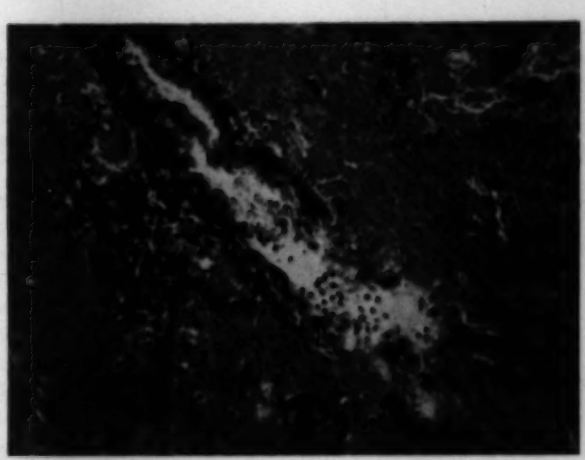

Fig. 7 (Manschot). *Case 7* (P.A. 134, Rotterdam. Necrosis of short posterior ciliary artery. (Hematoxylin-elastin, ×100.)

Fig. 8 (Manschot). *Case 8* (P.A. 65, Rotterdam). Necrosis of short posterior ciliary artery. (Hematoxylin-eosin, ×140.)

Fig. 9 (Manschot). *Case 9* (P.A. 104, Rotterdam). Necrosis of short posterior ciliary artery. (Hematoxylin-elastin, ×225.)

CASE 9

M. A. L., a woman, aged 68 years, developed an expulsive hemorrhage one hour after an intracapsular lens extraction. Enucleation was performed seven days later. No history or signs of glaucoma were known. The systolic and the diastolic blood pressure were, respectively, 230 mm. Hg and 110 mm. Hg. The aorta was enlarged; the left ventricle of the heart was hypertrophic. The renal function was disturbed; the urine could only be concentrated to a specific gravity of 1,019. Catheter urine contained no albumin; some leukocytes were found in the sediment.

*Anatomic examination* (P.A. 104) showed the characteristic picture of a large subchoroidal hemorrhage which filled the eye. The hemorrhage originated from a necrotic short posterior ciliary artery (fig. 9). No symptoms of glaucoma could be found.

CASE 10

G. v. N.-W., a woman, aged 71 years, had suffered from essential hypertension for many years. Two years ago a cerebral hemorrhage occurred. The systolic blood pressure varied between 210 and 230 mm. Hg; the diastolic blood pressure varied between 120 and 140 mm. Hg. The renal function was intact; the urine could be concentrated to a specific gravity of 1,026, and it contained no albumin, no glucose, and no abnormalities in the sediment. No clinical signs of glaucoma were present. An expulsive hemorrhage occurred within two hours after an intracapsular lens extraction, which was performed without the use of adrenalin. The eye was enucleated two days later.

*Anatomic examination* (P.A. 1698, Amsterdam) revealed a large subchoroidal hemorrhage which filled the eye. Two ruptured short posterior ciliary arteries were found; their intrascleral part showed a nearly normal structure; at the inner side of the sclera, however, an aneurysmic dilation of the necrotic vessel walls was present. Intramural hemorrhages were visible, and the vessels were surrounded by accumulations of polynuclear leukocytes. A ruptured necrotic long posterior ciliary artery showed hyaline degeneration, intramural hemorrhages, total loss of its normal structure, and a perivascular accumulation of leukocytes (fig. 10). Many choroidal arterioles showed a hyaline degeneration. No anatomic symptoms of glaucoma could be found.

Fig. 10 (Manschot). *Case 10* (P.A. 1698, Amsterdam). Necrosis of long posterior ciliary artery. (Hematoxylin-eosin, ×65.)

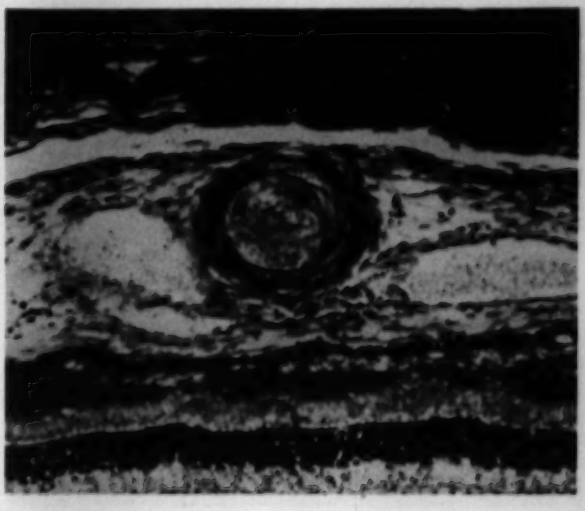

Fig. 11 (Manschot). *Case 11* (T. 16074, municipal hospital, Rotterdam). Necrotic choroid artery with intramural hemorrhage. (van Gieson, ×170.)

COMMENT

The anatomic findings in these four cases (7 to 10) confirm the previous conclusion that an expulsive hemorrhage originates from a ruptured necrotic posterior ciliary artery. It has become necessary, however, to broaden our conception regarding the etiology of this intraocular vascular necrosis.

Intraocular vascular necrosis is mentioned almost nowhere in ophthalmologic literature. Cohen[6] and Müller[7] described chorioretinal arteriolar necrosis in patients with malignant hypertension. Auw Yang Sien[8] published a case of choroidal apoplexy, originating from a ruptured necrotic posterior ciliary artery in a woman, aged 56 years. The systolic blood pressure of this patient varied between 240 to 200 mm. Hg; the diastolic blood pressure varied between 150 to 130 mm. Hg. I also described[9] choroidal arteriolar necrosis, due to malignant hypertension in a man, aged 19 years, who died from a cerebral hemorrhage (Case 11: figs. 11 and 12).

It is of importance that the vascular degeneration in the cases of Cohen, Müller, and my Case 11 was more severe within the eye than elsewhere in the body.

The Cases 7 to 11, together with the cases of Cohen, Müller, and Auw Yang Sien, prove that intraocular vascular necrosis can have an etiology other than glaucoma. Case 7 concerned an old man who suffered from a general arteriosclerosis. His blood pressure was extremely low. Cases 8 to 11 showed a very high blood pressure. It appears from these cases that general arteriosclerosis or a high blood pressure can be an etiologic factor in the occurrence of intraocular vascular necrosis.

Müller thought the necrosis to be the latest stage of an allergic-hyperergic damage of the vascular mesenchyma. This view does not explain, however, why the vascular degeneration is more severe within the eye than elsewhere in the body.

An always neglected factor in the pathogenesis of intraocular vascular degeneration is the normal intraocular pressure. This "normal" extravascular pressure within the eye is 20 to 25 mm. Hg higher than the (atmospheric) extravascular pressure elsewhere in the body, except for the intracranial pressure which is 10 to 12 mm. Hg higher than the atmospheric pressure. The blood pressure in the intraocular arterioles may be estimated about one half of the diastolic

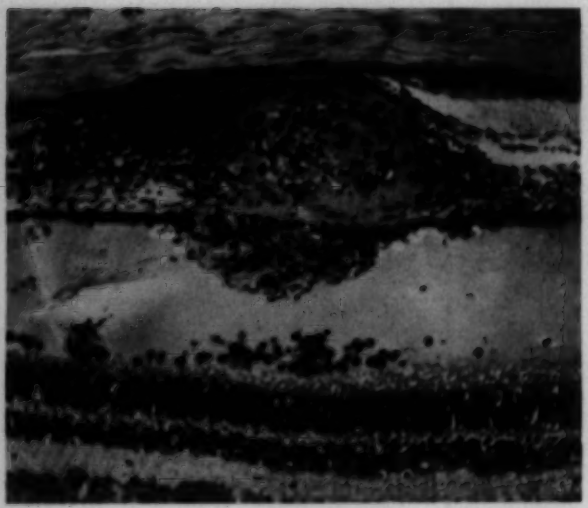

Fig. 12 (Manschot). *Case 11* (T. 16074, municipal hospital, Rotterdam). Necrotic choroid artery with thrombus formation. (Hematoxylin-eosin, ×145.)

blood pressure (Best and Taylor[10]). The blood pressure in capillaries is about one sixth of the diastolic blood pressure (Moon[11]).

As fluid can flow through a collapsible tube only so long as the fluid pressure within the tube is equal to or greater than the sum of the pressures exerted externally on that tube, it is easy to understand that an increase of the extravascular pressure of 20 to 25 mm. Hg must have a definite effect on the quantity and the speed of the blood that passes through the arterioles. It has already been shown (Thoma and others) that a slackening of the peripheral plasmatic part of the blood column within a vessel causes a derangement of the metabolism of the vessel wall, and that arteriosclerosis must be considered a direct consequence of this derangement ("angiomalacia").

The nutrition of a vessel wall is accomplished by (1) the penetration of plasma constituents through the endothelium, (2) vasa vasorum, and (3) penetration of extravascular tissue fluid. All investigators agree that arterioles do not possess vasa vasorum. Thus the nutrition of the arteriolar wall is only accomplished by a penetration of fluid from inside and from outside the vessel wall. Both streams do not flow in an opposite direction and do not meet somewhere in the media, but there is a diffuse penetration of the vessel wall with nourishing fluid, which is ultimately discharged into the perivascular tissue, and not into the vascular lumen (Lange[12]).

Experiments of Lange have shown that every factor which impedes this intramural fluid circulation will cause a degeneration of the vessel wall. Concerning the intraocular vascular degeneration these factors may be:

1. *High blood pressure,* causing arteriolar sclerosis.

2. *General arteriosclerosis.* The structural changes in the arteriolar wall will hamper the intramural circulation of fluid. Moreover, the intramural circulation in these cases will be influenced by the circumstance that the passage of blood through the vessel has been reduced by the lessened elasticity of the sclerotic vessel, and by the narrowing of the lumen by intimal proliferation. Thrombus formation, sometimes encountered in cases of expulsive hemorrhage and

malignant hypertension, can also play a part in the reduction of the passage of blood through the arterioles.

3. *Intraocular pressure.* An increased extravascular pressure will interfere with the intramural circulation by hampering the outflow of the circulating fluid. The passage of blood through the vessel will also be reduced by an increased extravascular pressure. The intraocular pressure can even exceed the arteriolar blood pressure; in these cases the vessel will collapse. In the smallest arterioles the pulse pressure is reduced to nearly zero; the lumen therefore will not reopen during systole. Thus an ischemic necrosis of the vessels can occur.

The importance of the extravascular pressure for the etiology of intraocular vascular necrosis is clearly demonstrated in the cases in which the necrosis occurred in glaucomatous eyes of patients who did not suffer from high blood pressure or general arteriosclerosis.

A combination of glaucoma and high blood pressure or general arteriosclerosis could be the causative factor of the vascular necrosis in most cases; this combination, however, is not imperative.

The fact that the extravascular pressure within the eye is higher than elsewhere in the body explains why the vascular degeneration in cases of general vascular disease is often more severe within the eyes than in other organs. It also explains why the intraocular vascular degeneration is located by preference at the point where the vessels enter the eye; in other words where they pass from the atmospheric extravascular pressure into the intraocular extravascular pressure. Bailliart[13] described this location in cases of sclerosis of the central retinal artery; Ennema[14] and others described it in their studies on closure of the central retinal vein; I found it also in many of my cases of expulsive hemorrhage.


## Summary

Histologic examination of 10 eyes in which an expulsive hemorrhage had occurred revealed that these hemorrhages originate from ruptured necrotic posterior ciliary arteries. An important factor in the pathogenesis of intraocular vascular degeneration is the circumstance that the extravascular pressure within the eye is about 20 to 25 mm. Hg higher than the (atmospheric) extravascular pressure elsewhere in the body.

The nutrition of an arteriolar wall is accomplished by a diffuse penetration of fluid from inside and from outside the vessel. The fluid is ultimately discharged into the perivascular tissue.

This fluid circulation within the intraocular arteriolar walls can be hampered by three factors: (1) *high blood pressure*, causing arteriolar sclerosis; (2) *general arteriosclerosis*, both by means of the structural changes in the arteriolar wall, and by a reduced passage of blood through the vessel; and (3) the *intraocular pressure*.

An increased extravascular pressure hampers the outflow of the circulating intramural fluid and reduces the passage of blood through the vessel. In glaucoma the intraocular pressure can exceed the arteriolar blood pressure. In these cases the vessels remain closed, and an ischemic necrosis can occur, even in otherwise unimpaired vessels.

The necrosis of the posterior ciliary arteries in most cases of expulsive hemorrhage may be induced by a combination of glaucoma and high blood pressure or general arteriosclerosis. This combination is, however, not imperative; every one of the three factors mentioned above can produce the vascular necrosis by itself.


*Nieuwe Binnenweg 157.*

I am indebted to Ejnar Munksgaard, publisher of the Acta Ophthalmologica, Copenhagen, Denmark, for permission to republish Figures 1 through 6.

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# MORPHOLOGY OF THE FIXED CELLS OF THE CORNEA*

## Of the rabbit following incision


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### Introduction

Investigations of the histology of the cornea with conventional methods and with the older metallic impregnations of Cajal and Bielschowsky or with the methylene-blue technique offer little information, since with these methods it is not possible to analyze the intricate structure of the fixed cells of the cornea, especially under pathologic conditions.

The technical difficulties are to a great extent alleviated by the silver-carbonate method of P. del Rio Hortega which permits impregnation of the cells and the nerves in man and animals under normal and pathologic conditions (Prieto Diaz,[1] Scharenberg,[2] Sverdlick[3]). We used this technique for the study of the fixed cells of the cornea of the rabbit following incision.

### Material and Method

Incisions with the keratome were made into the corneas of rabbits. The eyes were enucleated 50 minutes and one, two, three, four, and seven days respectively after the incision. The cornea was fixed immediately in bromformol (Cajal solution), cut horizontally on the freezing microtome, and impregnated with silver carbonate, utilizing the "panoptic method" of del Rio Hortega which permits exact microphotographic recording (Scharenberg[2, 4]).

### Histologic description

The normal fixed cell of the cornea of the rabbit is oval or irregular in shape and its cytoplasm contains a large round or elongated eccentric nucleus and delicate granules. Numerous long, mostly straight, processes interconnect the cells; from the primary processes smaller offshoots arise at


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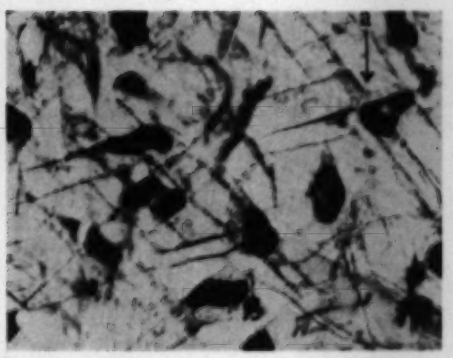

Fig. 1 (Wolter and Shapiro). Normal fixed cells of the cornea of rabbit (a). Spaces between the cells are filled with faintly impregnated corneal lamellae. Horizontal section. Hortega method. Magnification, ×700.

an angle. The cellular pattern is that of a syncytium. Spaces between the cells and their processes are filled with faintly impregnated corneal lamellae (fig. 1).

Fifty minutes following incision changes in the structure of the fixed cells near the wound are already very distinct. The cells appear larger than normal and the granules of the cytoplasm are coarser; the processes are swollen and begin to break down, the syncytial pattern of the tissue is lost, but the pattern of the corneal lamellae between the fixed cells is still unchanged (fig. 2).

Twenty-four hours following the operation, the cells near the edge of the wound are enlarged, their cytoplasm is homogeneous and partly necrotic, and their processes have disappeared (fig. 3), but the area of partial necrosis is very narrow and measures between one and two mm. Adjacent to this heavily damaged area, the cells are already very active. Their cytoplasm is swollen, homogeneous, and very argentophile, the processes are large and begin to branch, but the tissue contains numerous fragments of broken down cells (fig. 4). The lamellae of the cornea have lost their regular arrangement and their fibers are wavy (figs. 3 and 4).

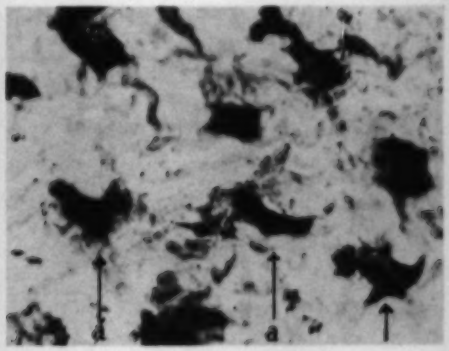

Fig. 3 (Wolter and Shapiro). Partial necrosis of fixed cells near the edge of the wound 24 hours after operation (a). Horizontal section. Hortega method. Magnification, ×700.

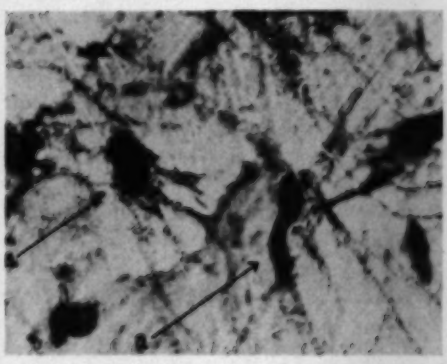

Fig. 2 (Wolter and Shapiro). Early changes in the fixed corneal cells (a) 50 minutes following incision. Horizontal section. Hortega method. Magnification, ×700.

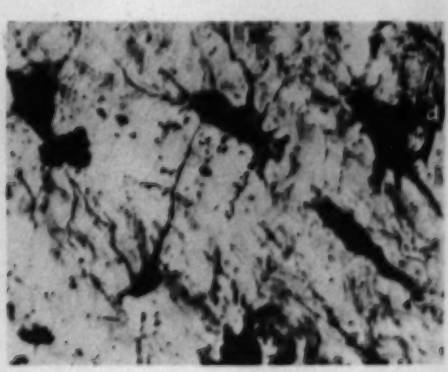

Fig. 4 (Wolter and Shapiro). Active fixed elements 24 hours following incision (a). Horizontal section. Hortega method. Magnification, ×700.

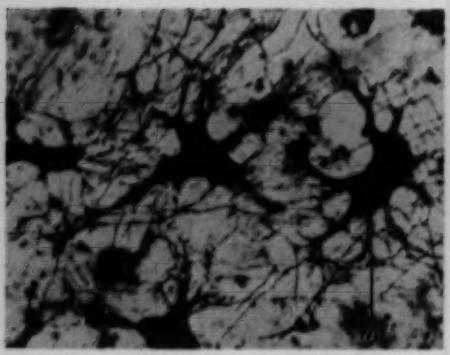

Fig. 5 (Wolter and Shapiro). Star-shaped, hypertrophic, very argentophile fixed corneal cells 48 hours after operation (a). Horizontal section. Hortega method. Magnification, ×700.

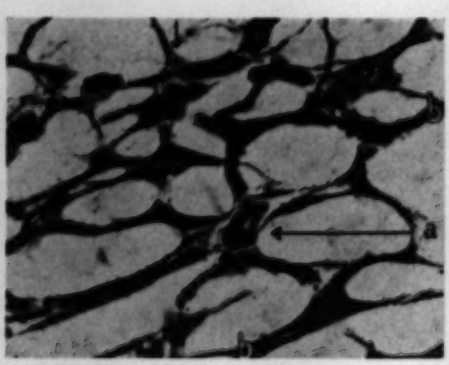


Fig. 7 (Wolter and Shapiro). Elongated fixed cells (a) with bridgelike connecting processes (b) 96 hours after incision. Horizontal section. Hortega method. Magnification, ×700.

Forty-eight hours after incision the morphology of the fixed cells and their pattern are definitely changed. The fixed elements are greatly hypertrophic, the cytoplasma is still very argentophile, and stains so deeply with silver carbonate that neither the nucleus nor the intracellular structures can be seen. The cells are star-shaped and have numerous coarse, widely branched processes which form a dense and irregular network. The normal syncytial character is not yet restored (fig. 5).

Seventy-two hours after incision further changes have taken place. The fixed cells are very large and irregular in shape, the nuclei have become faintly visible; all cells are interconnected by a maze of hypertrophic processes; the syncytial character of the tissue has been restored (fig. 6).

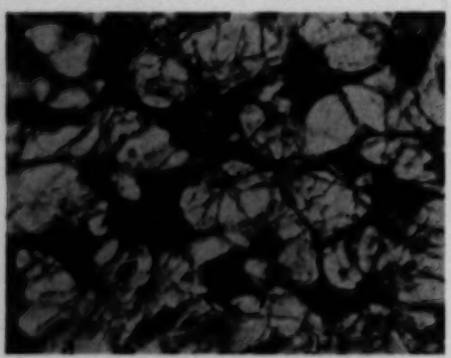

Fig. 6 (Wolter and Shapiro). The syncytial character of the tissue has been restored. Star-shaped fixed elements 72 hours following incision (a). Horizontal section. Hortega method. Magnification, ×700.

Ninety-six hours following incision the fixed cells near the edge of the wound have become elongated, their nuclei are well defined, the structures of the cytoplasm are partly restored but are still bulky. The processes now form powerful plasmatic bridges; all delicate processes have disappeared. The pattern of the syncytium has become more regular (fig. 7). These elongated elements unite the edges of the wound.

At 168 hours (seven days) after incision, the process of heeling is virtually completed, and long, bipolar, hypertrophic elements placed in parallel rows perpendicular to the incision have consolidated the wound. The cytoplasm of these elements stains very dark and their plasmatic structure including the nucleus remains poorly visible. The pattern of the scar is definitely that of a syncytium, but the intercellular network of the corneal lamellae is not visible (fig. 8).

The most compact scar tissue, built of elongated fixed elements, is formed around the sutures. The morphology of these elements is identical with those in the area of

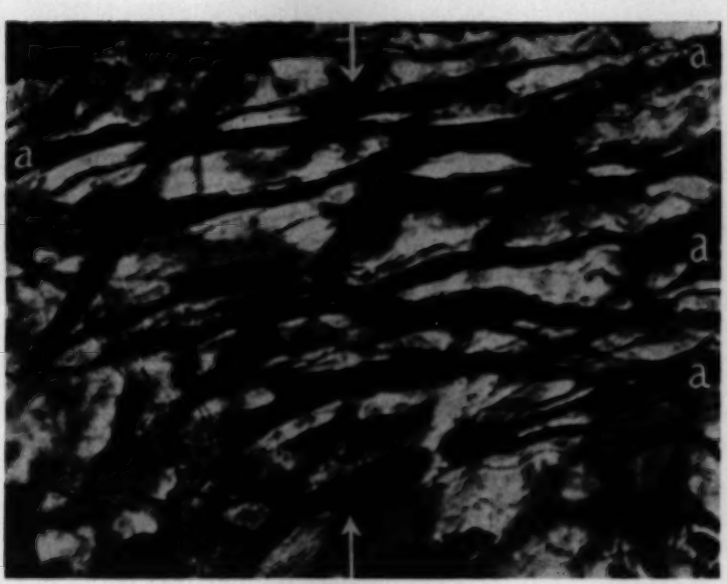


Fig. 8 (Wolter and Shapiro). Fresh scar seven days following incision with parallel rows of long bipolar fixed cells (a). Arrows indicate direction of original wound. Horizontal section. Hortega method. Magnification, ×700.

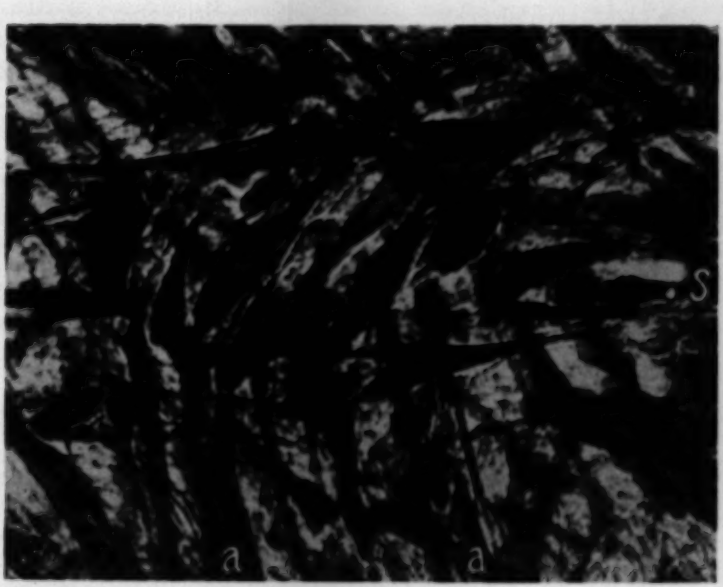


Fig. 9 (Wolter and Shapiro). Concentrically arranged fixed elements (a) surrounding a suture, seven days following incision. "S" indicates position of the suture. Horizontal section. Hortega method. Magnification, ×700.

incision, but the pattern is different. The majority of cells are arranged concentrically around the sutures rather than perpendicularly to the wound as in the area of the incision (fig. 9).

## Summary

Distinct degenerative changes of the fixed cells of a previously normal cornea of a rabbit can be observed in silver carbonate preparations less than one hour following incision and consist of swelling of the cell body, breaking down of the processes, and gradual loss of the normal syncytial character of the tissue.

Swelling, hypertrophy, and partial necrosis become distinct 24 hours after incision; 48 hours after the operation the hypertrophic cells develop widely branched processes without definite pattern. The rebuilding of the injured area continues rapidly and, 72 hours after incision, the syncytial character of the tissue is restored. In the next 24 hours very definite changes in the morphology of the cells take place. The fixed elements become very long, are interconnected by coarse bridgelike processes, and their intracellular structures are partly visible. These elongated elements bridge the wound. At 168 hours (seven days) after the injury, the consolidation of the wound by parallel rows of elongated fixed cells is completed. Around the sutures the fixed cells are generally arranged concentrically and a particularly dense scar is formed.

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# EVALUATION OF CERTAIN OPTICAL DEVICES IN THE CORRECTION OF SUBNORMAL VISION*

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During the past 18 months we have attempted to evaluate certain optical devices used for the correction of poor visual acuity which is not correctible with ordinary spectacles. The optical devices employed were (1) telescopic lenses with magnifications of 1.5 and 2.0,[a] (2) telescopic lenses with magnifications of 1.7 and 2.2,[b] and (3) microscopic lenses with magnifications of 2 to 20 diameters in steps of 2X, 4X, 6X, 8X, and so forth.[c] Included in this report is a brief discussion of our experiences with hemianopsia spectacles.

Often the practicing ophthalmologist may overlook these devices in his plans for patients with subnormal vision. We are, therefore, presenting this material to re-emphasize the fact that there are many patients who can be benefited by one or more of these optical devices. Many of the patients in our series had been unable to read for years prior to obtaining their subnormal vision aids.

Enlargement of the retinal image by magnification is an obvious advantage in the presence of a scotoma. This facilitates the recognition of objects viewed by the patient with subnormal vision, and improvement in visual acuity resulted in all cases reported herein (figs. 1 and 2).

The usual subnormal vision patient has visual acuity of 20/100 or less at distance and J3 or less at near. Thirty-three such patients, ranging from eight to 88 years of age, were fitted with telescopic and/or microscopic lenses during the past 24 months. In each instance plus lenses of from 5.0 to 20 diopters were added to the present distance correction but were found inferior to either telescopic or microscopic lenses. Many of these patients, prior to our examination, had been using hand magnifiers. It was determined while obtaining their histories whether improvement in distance or near

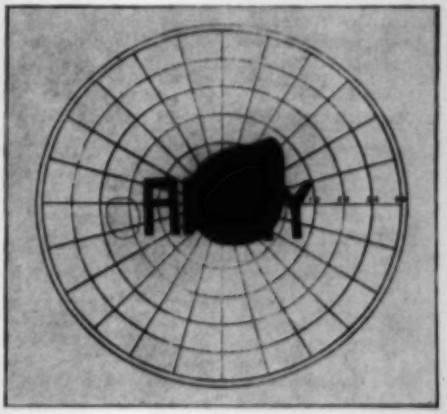

Fig. 1 (Levi and King). Illustrating retinal image of patient with central scotoma. Patient is looking at the word "Army."

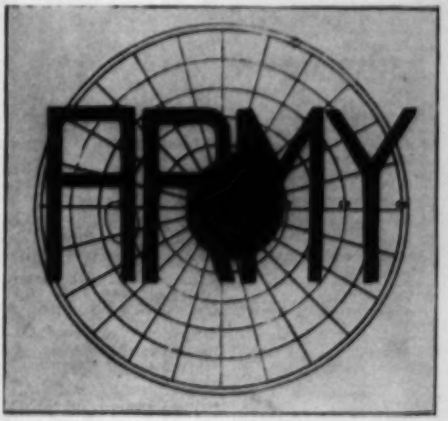

Fig. 2 (Levi and King). Illustrating how magnification of the retinal image shown in Figure 1 facilitates recognition of the word "Army."

* From the Ophthalmology Service, Walter Reed Army Hospital.

[a] Univis telescopic lens.

[b] Kollmorgen telescopic lens.

[c] Feinbloom microscopic lens.

## TABLE 1

PATIENTS FOR WHOM TELESCOPIC AND/OR MICROSCOPIC LENSES WERE PRESCRIBED
(Total—33 Patients)

| Patient Number and Diagnoses | Subjective Rx | Visual Acuity | | Subnormal Lens Prescribed | Vosual Acuity | |
|---|---|---|---|---|---|---|
| | | Distance | Near | | Distance | Near |
| No. 1 Age: 80<br>Macular degeneration, senile. | OD, −3.50s +0.50 cx<br>OS, +1.00 cx | 20/200+<br>20/200− | J-10<br>J-0 | Kollmorgen telescopic spectacles:<br>1.7 with +8.00 add<br>1.7 | 20/100<br>20/100 | J-1<br>J-1 |
| No. 2<br>Optic atrophy, OU | OD, +1.25s −2.26 cx 90<br>OS, +2.25s −3.50 cx 90 | 10/200<br>Fingers @ 6 ft. | J-0<br>J-0 | Kollmorgen telescopic spectacles:<br>2.2 with +8.00 add | 20/80<br>20/100 | J-1<br>J-1 |
| No. 3<br>Corneal dystrophy, OU. | OD, −5.00s<br>OS, −6.00s | 20/200<br>20/200 | J-8<br>J-9 | Kollmorgen telescopic spectacles:<br>2.2 with +8.00 add | 20/40<br>20/40 | J-1<br>J-1 |
| No. 4 Age: 69<br>Macular degeneration, OU. | OD, Balance<br>OS, +2.50s | 20/60 | J-8 | Kollmorgen telescopic spectacles:<br>1.7 with +4.00 add | 20/30 | J-1 |
| No. 5 Age: 75<br>Macular degeneration. | OD, No Rx improves VA | 20/200 | J-0 | Kollmorgen telescopic spectacles:<br>2.2 with +6.00 add | 20/60 | J-1 |
| No. 6 Age: 8<br>Congenital coloboma, nystagmus, etc. | OD, −12.00s<br>OS, VA not correctible, nil | 20/400<br>Holds print very close to magnify. | J-7 | Kollmorgen telescopic spectacles:<br>2.2 with +12.00 add | 20/100 | J-1 |
| No. 7 Age: 34<br>Chemical burn (bichloride Hg), cornea. | OD, No Rx improves VA | 20/400<br>Pinhole | J-4 | Kollmorgen telescopic spectacles:<br>2.2 with +8.00 add | 20/200+ | J-1 |
| No. 8 Age: 23<br>Retinal detachment, OU | OD, +0.75s<br>OS, −0.75s −1.75 cx 180 | 20/200<br>20/200 | J-10<br>J-10 | Kollmorgen telescopic spectacles:<br>2.2 with +10.00 add<br>2.2 (also +4 and +6 adds) | 20/100<br>20/100 | J-2<br>J-2 |
| No. 9 Age: 11<br>"Atypical" Leber's or familial optic atrophy, OU. | OD, +1.00s<br>OS, +1.00s | 20/400<br>20/100 | J-0<br>J-8 | Kollmorgen telescopic spectacles:<br>1.7 with +6.00 add | 20/40<br>20/45 | J-1<br>J-1 |
| No. 10 (POW)<br>Nutritional amblyopia. | OD, +0.75s<br>OS, +1.50s | 20/350<br>20/200 | J-11<br>J-11 | Kollmorgen telescopic spectacles:<br>2.2 with +6.00 add<br>+4.00 add | 20/200+<br>20/150 | J-1<br>J-1 |
| No. 11 Age: 34 (POW)<br>Nutritional amblyopia. | OD, −0.75s<br>OS, −0.25s −0.25 cx 30 | 20/300<br>20/200 | J-0<br>J-6 | Univis telescope:<br>Mag 2 with + 8.00 add<br>+10.00 add | 20/200<br>20/113 | J-2<br>J-1 |
| No. 12 Age: 26 (POW)<br>Nutritional amblyopia. | OD, +0.50s −0.25 cx 180<br>OS, +0.50s −0.50 cx 155 | 20/200<br>20/200 | J-0<br>J-0 | Kollmorgen telescopic spectacles:<br>2.2 with +8.00 add | 20/130<br>20/140 | J-1<br>J-1 |
| No. 13 Age: 23<br>Macular degeneration since childhood. | OD, No Rx improves VA<br>OS, Essentially emmetropic | 8/400<br>4/400 | J-0<br>J-0 | Microscope<br>×6 | Telescope does not materially improve dist. vision | J-1 |
| No. 14 Age: 12<br>Retinitis pigmentosa. | OD, +0.75s +2.50 cx 90<br>OS, +0.75s +2.50 cx 90 | 20/200<br>20/200 | J-11<br>J-11 | Univis telescope:<br>Mag 2 with +10.00 add<br>+ 4.00 add | 20/100<br>20/100 | J-1<br>J-1 |
| No. 15 Age: 88<br>Cataracts, macular degeneration. | No Rx improves VA | 20/200<br>20/250<br>(add +3.00) | J-7<br>J-9 | Univis telescope:<br>Mag 2 with +10.00 add | 20/150<br>20/180 | J-1<br>J-1 |
| No. 16 Age: 35 (POW)<br>Nutritional amblyopia. | OD, +0.25s<br>OS, −0.25s −0.25 cx 90 | 20/100<br>20/300 | J-11<br>J-11 | Microscope<br>OD, ×4; OS, ×6 | 20/100<br>15/200 | J-1<br>J-1 |
| No. 17 Age: 35 (POW)<br>Nutritional amblyopia. | OD, −0.75s<br>OS, −0.75s | 20/70<br>20/70 | J-9<br>J-11 | Univis telescope:<br>Mag 2 with +4 and +6 adds | 20/60<br>20/60 | J-1<br>J-1 |
| No. 18 Age: 25 (POW)<br>Nutritional amblyopia. | OD, No Rx improves VA<br>OS, No Rx improves VA | 20/400<br>20/100 | J-0<br>J-8 | Univis telescope:<br>×1.5 OU with +8.00 and +4.00 adds | 20/200<br>20/40 | J-5<br>J-1 |
| No. 19 Age: 19<br>Macular degeneration (Kuhnt Junius type). | OD, No Rx improves VA<br>OS, No Rx improves VA | 20/70<br>20/40 | J-6<br>J-5 | Feinbloom microscope:<br>×4, ×2 | | J-1<br>J-1 |
| No. 20 Age: 21<br>Perforating wounds of both eyes. | OD, Blind<br>OS, +9.00s +1.00 cx 180 | 20/80<br>(add +3.00) | J-5 | Microscope<br>×4 with +6.00<br>Lens to correct refractive error | | J-1 |
| No. 21 Age: 79<br>Macular degeneration. | OD, Eye enucleated<br>OS, −0.25s +0.50 cx 165 | 20/70<br>(add +2.00) | J-3 | Kollmorgen telescopic spectacles:<br>1.7 with +4 and +6 adds | 20/40 | J-1 |
| No. 22 Age: 70<br>Aphakia, posttraumatic and distorted iris, OD; amblyopia, congenital, OS. | OD, +3.50s<br>OS, +5.50s −2.00 cx 35 | 20/200<br>20/70 | J-0<br>J-10 | Feinbloom microscope (OS):<br>×2 | | J-1 |
| No. 23 Age: 78<br>Macular and perimacular degeneration, OU. | OD, not correctible<br>OS, +2.00s +0.50 cx 45 | LP only<br>20/200 | J-0 | Feinbloom microscope (OS):<br>×4 | | J-1 |

TABLE 1—(*continued*)

| Patient Number and Diagnoses | Subjective Rx | Visual Acuity | | Subnormal Lens Prescribed | Visual Acuity | |
|---|---|---|---|---|---|---|
| | | Distance | Near | | Distance | Near |
| No. 24 (POW)<br>Nutritional amblyopia. | Plano, OU | 20/200<br>20/200 | | Feinbloom microscope:<br>OD, ×6; OS, ×6 | | J-1<br>J-1 |
| No. 25<br>Aphakia, macular degeneration, glaucoma. | OD, +12.75s −3.50 cx 90<br>OS, +12.00s −0.50 cx 90 | 20/200<br>20/800 | J-8<br>J-0 | Microscope<br>OD, ×4 with +10.00 to correct refractive error; OS, balance | | J-1<br>J-1 |
| No. 26<br>Congenital amblyopia, OD; wound to OS in Korea, corneal scar, hazy vitreous. | OD, Plano<br>OS, Not correctible | 20/200<br>LP | J-5 | Microscope<br>×8 OD Plano | | J-2 |
| No. 27 (POW)<br>Nutritional amblyopia. | Plano, OU | 20/70<br>20/100 | J-10<br>J-11 | Univis telescope:<br>Mag 1.5 with adds of +6 and +8 | 20/40<br>20/50 | J-1<br>J-1 |
| No. 28 (POW)<br>Nutritional amblyopia. | OD, −1.00s +0.50 cx 90<br>OS, −1.50s +0.50 cx 90 | 15/400<br>15/400 | J-0<br>J-0 | Univis telescope with −1.00s;<br>Feinbloom microscope, ×6 OU | 20/200<br>20/200 | J-1<br>J-1 |
| No. 29 (POW)<br>Nutritional amblyopia. | Plano, OU | 20/200<br>20/200 | J-0<br>J-0 | Univis telescope:<br>×2 with +10.00 add | 20/200× | J-1 |
| No. 30 (POW)<br>Nutritional amblyopia. | Plano, OU | 20/100<br>20/80 | J-9<br>J-8 | Microscope<br>OD, +6; OS, +4 | | J-1<br>J-1 |
| No. 31<br>Perforating wound. | OD, Blind<br>OS, No Rx improves VA | Blind<br>20/100 | | Microscope (OS)<br>×6 | | J-1 |
| No. 32<br>Macular degeneration. | OD, +7.50s +4.50 cx 10<br>OS, Balance | 20/100 | | Microscope<br>1.5 with +4.00 add | | J-1 |
| No. 33 (POW)<br>Nutritional amblyopia. | Plano, OU | 20/200<br>20/200 | J-0<br>J-0 | Microscope | | J-1<br>J-1 |

visual acuity or both was of paramount importance to the patient. The majority wished to improve near visual acuity. Most stated that they wanted to be able to read newsprint, magazines, and the telephone book. A few patients wanted to see television, movies, or other distant objects more clearly. The school children examined were eager to be able to "see the blackboard."

In general, the main concern of the elderly patients was to improve visual acuity at near. If an optical aid enabled them to read, they were satisfied.

### Method of fitting

Fitting the lenses is relatively simple. First, a routine refraction is performed. Then, while a telescopic lens is worn in the anterior cell of the trial frame, the subjective correction in the posterior cells is modified to obtain best visual acuity at distance. To determine the necessary telescopic reading addition, additive lenses from the telescopic trial case are slipped over the telescopic lens. For reading it is not practicable to obtain binocular vision with either telescopes or microscopes. If both eyes can be corrected to give useful near vision, an occluder must be provided to cover the eye not in use at the moment. After carefully explaining the proper use of the lenses, it is surprising how easily most patients adapt to them. Motivation is, of course, important.

Table 1 shows visual acuity at distance and near with subjective $R_x$ and with subnormal lens prescribed. Table 1a lists the various pathologic conditions which resulted

TABLE 1A

Diagnoses—subnormal vision cases

| Diagnoses | Number of Patients |
|---|---|
| Macular degeneration | 9 |
| Optic atrophy | 3 |
| Corneal dystrophy | 1 |
| Nystagmus, congenital | 1 |
| Corneal opacities<br>Various causes—trauma, keratitis, etc. | 1 |
| Retinal detachment | 1 |
| Nutritional amblyopia<br>(prisoners of war) | 12 |
| Retinitis pigmentosa | 1 |
| Ocular trauma | 3 |
| Amblyopia, congenital | 1 |
| Total number of patients | 33 |

TABLE 2

VISION WITH AND WITHOUT OPTICAL AID (DISTANCE ONLY)

| Vision without Optical Aid | Number of Patients | Vision with Telescopic Spectacles (Expressed as percentage of visual efficiency) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (Percentages are approximate) | | 100% | 90% | 75% | 70% | 60% | 50% | 40% | 30% | 20% | 10% | 5% | Less than 5% |
| 20/60 (70%) | 1 | | 1 | | | | | | | | | | |
| 20/70 (65%) | 4 | | | 2 | 2 | | | | | | | | |
| 20/100 (50%) | 2 | | | | | 1 | 1 | | | | | | |
| 20/200 (20%) | 14 | | | | 2 | 1 | 8 | 1 | 2 | | | | |
| 20/300 (10%) | 2 | | | | | | | | | 2 | | | |
| 20/400 (3%) | 5 | | | 1 | | | 1 | | | 3 | | | |
| Less than 20/400 (3%) | 3 | | | | | | 1 | | | 2 | | | |

in subnormal vision. Telescopic lenses were prescribed for 20 patients and microscopic lenses for 13.

Table 2 compares the best vision which can be obtained without the subnormal vision device with that secured by the use of the visual aid. The visual acuity at distance only is recorded and is expressed as percentage of visual efficiency. The telescopic lenses enable the patients to enjoy such recreations as movies and television.

Each patient was asked nine pertinent questions in order to determine the relative merits of each type of lens (table 3). Answers to these and other questions revealed the fact that many patients chose microscopic lenses because they permitted a wider field of vision than the telescopic lenses. Others did not like the shorter focal lengths of the microscopes as compared to the telescopes (fig. 3). One of our patients has devised an ingenious reading combination by placing a pinhole between the telescopic lens and his eye. This increases the distance at which he can hold reading matter (fig. 4). From the standpoints of field of vision, appearance, and portability, the microscopic lens was the unanimous choice (table 3). Type a and Type b telescopes were found to be equal in optical performance, but the majority of patients preferred the Type a because it was lighter in weight. In addition, the Type a lens is mounted in the center of plano spectacle lenses which can be edged to any size and shape. This permits a wide selection of

TABLE 3

PATIENTS' ANSWERS TO NINE PERTINENT QUESTIONS REGARDING VARIOUS ASPECTS OF TELESCOPIC AND MICROSCOPIC LENSES

| Questions | Telescope B | Telescope A | Microscope C |
|---|---|---|---|
| 1. Field of vision | 0 | 0 | 29 |
| 2. Clearness of detail | 4 | 8 | 14 |
| 3. Rapidity and ease of reading | 4 | 8 | 14 |
| 4. Cosmetically best | 0 | 0 | 27 |
| 5. Easiest to obtain adequate lighting | 4 | 8 | 14 |
| 6. Least annoying from glare from extraneous light | 4 | 8 | 14 |
| 7. If you could afford only one lens, which would you choose—consider various adds, telescope | 4 | 8 | 14 |
| 8. Portability | 0 | 0 | 28 |
| 9. Do you desire a magnifying device for distance in addition to reading device? Yes—11 | | | |

(Table indicates more than 33 patients—due to some patients' desire for telescopic lenses for distance and microscopic lenses for reading)

modern frames, whereas Type b telescopic lenses are 38 mm. round and therefore can only be worn in a 38 mm. round frame.

### Homonymous hemianopsia

Although active ambulatory persons suffering from residual homonymous hemianopsia are few in number, they do need help. In traffic they are constantly in danger. They frequently collide with objects encountered on the "blind" side. Hemianopsia spectacles should be tried for these patients.

The spectacles consist of ordinary glasses with a small mirror mounted on the appropriate nasal side. The mirror reflects images of objects on the blind side onto the seeing retina of the ipsilateral eye.

Four patients were given these spectacles. One of these, a physician who was wounded in Korea, was also fitted with contact lenses at his request. He prefers contact lenses to spectacles because they enable him to glance rapidly from side to side in order to obtain a mental picture of his surroundings without the distortion and interference with vision encountered through his spectacles. Each of the patients using hemianopsia spectacles found the device highly satisfactory.

The physician-patient states:

The hemianopsia spectacles have very definite advantages and, like everything else, disadvantages. However, it is my opinion that the advantages outweigh the disadvantages.

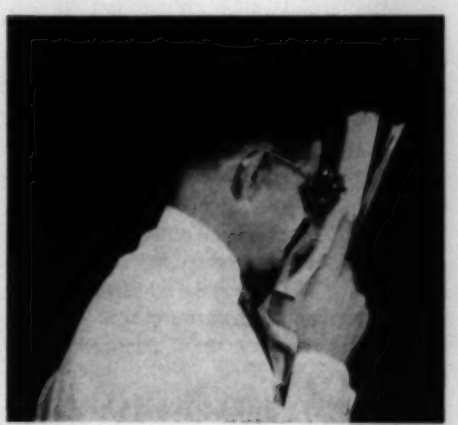

Fig. 3 (Levi and King). Patient reading with microscopic lens in trial frame.

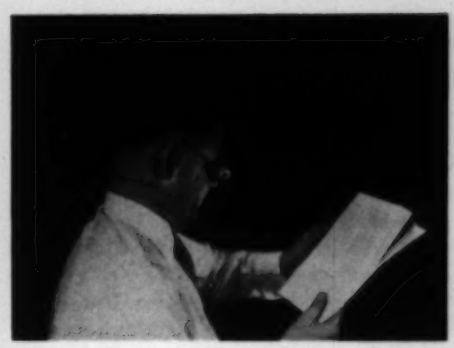

Fig. 4 (Levi and King). Patient reading with telescopic lens plus a pinhole in order to increase the "focal length."

The spectacles serve to replace that part of the peripheral field which is not functioning; hence, hemianopsia spectacles call our attention to movements on the blind side. In serving this purpose, these spectacles reflect movements of a gross nature and of sudden, close movements. With the attention being called, the macular vision can then be trained on the important motions. However, differentiation between important and unimportant movements is impossible unless the macular vision is used. For this reason, I have not been able to wear hemianopsia spectacles when driving at night because of the myriad of passing lights that are picked up. Not all of these can be looked at directly and confusion arises when an attempt is made to concentrate on the road. The glasses are no hindrance when used for daylight driving, but, because scanning has proved so important to me when driving during the day, I use the hemianopsia spectacles less while driving than otherwise.

Contact lenses should prove valuable to most hemianopsia patients, particularly for those who are physically active. These patients rely on scanning and with contact lenses are able to scan without having to look at the edge of their spectacle frames or turn their heads completely. Our doctor-patient suggests training on the tachistoscope to improve ability to scan. He finds both contact and hemianopsia spectacles of value and would not like to be without either.

### Summary

Subnormal vision (table 1a) is due to many causes and afflicts patients of every

age. When visual acuity cannot be materially increased with ordinary spectacles, telescopic or microscopic lenses should be tried.

In general, elderly patients in this series did not desire lenses for magnification of distant objects, since reading was their prime concern. Cosmetically, and from the standpoint of field of vision, microscopic lenses were preferred. The chief objection to the microscopic lenses was their very short focal lengths. Microscopic lenses provide very high magnifications. Telescopic lenses a and b were equal in optical performance. Cosmetically, and from the standpoint of lightness, Type a is preferable.

Hemianopsia spectacles have been prescribed for four of our patients with homonymous hemianopsia. It is believed that many such patients will find this device useful provided they are first informed of its potentialities and restrictions. In selected hemianopsia cases, contact lenses may prove of value.

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## CYCLOGYL®: RE-EVALUATION AND FURTHER STUDIES*

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### Introduction

A new cycloplegic, Cyclogyl,® has been used clinically and the reports of these results have been published.[1-4] Several points concerning Cyclogyl® are to be stressed as important and useful in its clinical application.

It is not necessary to describe the elements of Cyclogyl® since this has been done by Priestly and Medine.[1] Further study was carried out by Stolzar[2] in a comparative series of similar related compounds. His report, however, did not include a direct comparison with homatropine. Gettes and Leopold[3] reported on five new anticholinergic drugs, among which was Cyclogyl.® The most recent work reported, as further evaluation of the drug, is by Milder and Riffenburgh.[4] They limited this work to the 0.5-percent solution, but did not compare it with homatropine (5.0 percent) in the same patient.

### Clinical significance

A supply of the preparation Cyclogyl® was obtained in 0.5-percent and 1.0-percent strengths by one of us (R. H. R.). It was noted that mydriasis was very rapid. Usually within 15 to 20 minutes the pupils were dilated so that adequate examination with the ophthalmoscope and slitlamp could be done. The residual accommodation was critically checked by employing the objective method of determining residual accommodation.[5] These results were found to be as good, and in most cases better than the results with homatropine (5.0 percent) which have been previously reported as around 0.57 diopters of residual accommodation averaged from all age groups.[5]

In the early experience with Cyclogyl,® it was noted that recovery from cycloplegia was rapid enough after using pilocarpine

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(1.0 percent) so that the postcycloplegic examination could be done the next day if necessary. This point was brought out in the conclusions of Milder and Riffenburgh.[4]

A point which is regarded as important in the use of the drug is the proper instillation. The drop should be placed on or preferably above the superior limbus of the eye while the eye is turned downward. This allows the solution to flow across the cornea and then form a pool in the lower cul-de-sac where the cornea remains in contact with the solution a little longer.

In the past, euphthalmine and ephedrine have been used routinely as a safe mydriatic in the elderly patient. The objection to its use has been the length of time necessary for mydriasis to occur—usually at least one hour and then occasionally a second instillation has to be done. The 0.5-percent solution of Cyclogyl® is as safe and mydriasis can be achieved in 20 minutes. Obviously, this is desirable, particularly in the older age group.

A mydriatic is used preoperatively in cataract surgery by many who prefer to have the iris sphincter relaxed. Cyclogyl® might be desirable in this capacity because of its rapidity of action. According to the records made in this series, it seems as though either the 0.5-percent or 1.0-percent solution will cause mydriasis in 15 to 20 minutes. It has been found that if the Cyclogyl® is instilled earlier than 20 minutes preoperatively, the pupil is almost too large in case a peripheral iridectomy is planned for a round-pupil procedure. Mydriasis is maintained after emptying the anterior chamber.

Cyclogyl® has also been found useful in fundus photography. It produces a much more profound mydriasis than other temporarily acting mydriatics, and therefore resists the counteracting effect (miotic) of the bright light necessary for fundus illumination.

## Procedure

After the visual acuity has been determined, both without and with correction, the amplitude of accommodation is measured. Cyclogyl® is then instilled, being sure that the drop comes in contact with the eye on or above the superior limbus.

The 1.0-percent solution of Cyclogyl® was used in all cases for refractions of patients under the age of 40 years, and the 0.5-percent in patients over the age of 40 years. Using only one drop was routine except in brunettes—then two drops were instilled. That a difference in complexion made it necessary to alter the amount of drops used was noted from work reported by Gettes and Leopold.[3]

The examination was started 30 minutes after the drops were instilled. On several occasions the examination was one hour late in being started, which was equivalent to 90 minutes after the drops were instilled.

The residual accommodation was checked after a plus-three diopter lens was added to the previously determined distance correction. The objective method, using the retinoscope and a test object attached to it, was employed.[5] For comparative reasons, two subjective methods for determining residual accommodation were included. These were the tests which use the printed letters on the sliding Prince rule.

In another series of cases, Cyclogyl® (1.0 percent) was instilled in the right eye of each patient and homatropine (5.0 percent) in methylcellulose and Zephiran® was instilled in the left eye. It was noted in this series that the more rapid mydriasis resulted from Cyclogyl® as compared with homatropine. Cyclogyl® also seemed consistently to give a larger dilated pupil.

The most important comparison is between homatropine (5.0 percent) which was previously published[5] and Cyclogyl® (1.0 percent). One of the interesting features in this series was that many of the cases recorded previously with homatropine were recorded several years later using Cyclogyl® (1.0 percent). In every instance, Cyclogyl® (1.0 percent) gave a lower residual accommodation than homatropine (table 2).

TABLE 1

RESIDUAL ACCOMMODATION COMPARISON OF SUBJECTIVE TEST WITH OBJECTIVE TEST USING CYCLOGYL® ONE PERCENT

| Refractive Groups | Hyperopia Group 1 0 to +1.00 | Hyperopia Group 2 +1.25 to +1.00 | Myopia Group 1 0 to −1.00 | Myopia Group 2 −1.25 to −2.50 | Compound Hyperopic Astigmatism | Compound Myopic Astigmatism | Mixed Astigmatism | Average of all Groups |
|---|---|---|---|---|---|---|---|---|
| **Subjective** | | | | | | | | |
| Residual Diopters | +0.55 | +0.59 | +0.71 | +0.66 | +0.55 | +0.55 | +0.53 | +0.59 |
| **Objective** | | | | | | | | |
| Residual Diopters | +.028 | +.0225 | +.05 | +.048 | +.037 | +.045 | +.04 | +.039 |
| Percentage Zero Accommodation | 90% | 91% | 76% | 87% | 88% | 90% | 75% | 85% |

## COMMENTS

Cyclogyl® as a cycloplegic is so consistently effective that it is difficult to arrive at any conclusion as far as percentages go. The simplest method was to count the number of eyes which had no residual accommodation. In most of the different refracting groups, the results were around 90 percent with no residual accommodation. A total of 302 patients were examined in this study.

In group one, which included all cases between plano and one diopter of hyperopia, there was only one case which had one diopter of residual accommodation, and two eyes with plus 0.50 residual. So that out of a total of 82 cases, 90 percent had no residual accommodation (table 1).

The first two groups of myopia dropped down to 76 percent with no residual accommodation in group one and 87 percent in group two (table 1). This is rather interesting when we realize that the myope is usually regarded as one who is likely not to have much accommodation.

The subjective test for determining the residual accommodation averaged around a plus 0.50 diopter of residual in trial 1, which was done by moving the test object away from the patient's eye (table 1). In trial 2 the test object was moved toward the patient until it went out of focus, and in this trial the average was plus 1.00 or plus 1.25 diopters of residual accommodation.

## CONCLUSIONS

1. Cyclogyl® as a cycloplegic with the best average of no residual accommodation (75

TABLE 2

RESIDUAL ACCOMMODATION COMPARISON CYCLOGYL® (ONE PERCENT) AND HOMATROPINE (FIVE PERCENT) IN ZEPHIRAN AND METHYLCELLULOSE

| Refractive Groups | Hyperopia Group 1 0 to +1.00 | Hyperopia Group 2 +1.25 to +2.50 | Myopia Group 1 0 to −1.00 | Myopia Group 2 −1.25 to −2.50 | Compound Hyperopic Astigmatism | Compound Myopic Astigmatism | Mixed Astigmatism | Totals and Averages |
|---|---|---|---|---|---|---|---|---|
| **Cyclogyl** | | | | | | | | |
| Residual Diopters | +.028 | +.0225 | +.05 | +.0481 | +.037 | +.045 | +.04 | +.0386 |
| Percentage Zero Accommodation | 90 | 91 | 76 | 87 | 88 | 90 | 75 | 85 |
| Age Limits | 6 to 65 | 5 to 52 | 6 to 67 | 8 to 49 | 8 to 60 | 13 to 62 | 6 to 62 | 7 to 58 |
| No. of Patients | 82 | 23 | 21 | 23 | 38 | 25 | 87 | 299 |
| **Homatropine** | | | | | | | | |
| Residual Diopters | +0.57 | +0.57 | +1.3 | +0.28 | +0.5 | +0.21 | +0.63 | +0.58 |
| Age Limits | 7 to 50 | 7 to 55 | 7 to 44 | 8 to 45 | 6 to 60 | 10 to 52 | 8 to 52 | 7 to 51 |
| No. of Patients | 46 | 15 | 10 | 11 | 52 | 10 | 25 | 169 |

percent to 90 percent) in age groups ranging from five years to 76 years has been investigated.

2. Cyclogyl® seems to arrive at its maximum effect in 30 minutes much the same as homatropine (5.0 percent) in methylcellulose and Zephiran.®

3. The recovery time from cycloplegia is much more rapid with Cyclogyl® than homatropine. Most patients were able at least to tell the time by wrist watch and actually read the newspaper within three to six hours after counteracting pilocarpine drops (1.0 percent) were instilled.

4. Postcycloplegic examinations can be done the next day in most cases if necessary.

5. The 1.0-percent solution of Cyclogyl® is recommended in all refraction patients up to the age of 40 years. The 0.5-percent solution of Cyclogyl® is recommended in most patients over the age of 40 years.

6. The 0.5-percent solution of Cyclogyl® seems to be a safe mydriatic in elderly patients and is more rapid in its action than euphthalmine and ephedrine.

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NOTE: Since the completion of this work, a new preparation of Cyclogyl® has been obtained. This is not generally available as yet. This preparation is 1.0-percent Cyclogyl® in 1.5-percent carboxymethylcellulose as a base which contains benzalconium chloride (Zephiran® 1:10,000). Its consistency is midway between a drop of solution and a jell and is dispensed from a one-eighth ounce tube. This makes it much easier to instill and the temporary blepharospasm following the instillation does not cause loss of the drug as with drop solutions. There is no smearing of the cornea as with ointments. It is better to instill this preparation inside the lower lid. Just as effective cycloplegia is obtained and blepharospasm is considerably reduced.

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# FACTORS IN THE GENESIS OF CORNEAL EDEMA

## A SLIGHTLY DIFFERENT VIEWPOINT OF THE MODE OF ITS PRODUCTION

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For descriptive purposes it is proposed to deal with this subject under five headings:

I. Relevant details of the anatomy of the cornea

II. Relevant points concerning the physiology of the cornea with reference to the work of other observers

III. My own observations and experiments

IV. Relevant properties of nerve fibers

V. Discussion and recapitulation of salient points.

### I. ANATOMY OF THE CORNEA

As we know, the cornea and sclera are basically identical collagenous tissues,[13] with the cornea differing from the sclera in the following respects:

a. The arrangement of the collagen fibers and their corpuscles.

b. The presence of Bowman's and Descemet's membranes.

c. Absence of blood vessels and a special modification of the vascular system as the canal of Schlemm.

d. An abundant supply of demyelinated corneal nerve fibers.

### II. RELEVANT POINTS FROM THE PHYSIOLOGY OF THE CORNEA

We know that, in spite of the basic similarity of structure and constituent sub-

stances, the cornea is a transparent tissue, whereas the sclera is opaque.

Fuchs was the first to point out that there is a relatively small amount of water in the corneoscleral tissue.

Leber showed that, when the cornea takes up water, it becomes opaque, and, when the sclera is hydrated, it becomes semitransparent. It would seem that whereas the sclera behaves as any other collagenous structure would, the cornea behaves in an exactly opposed manner. These observations were confirmed by Cogan and Kinsey[4] and other observers, so that it is now established that the cornea remains transparent only in the deturgescent state.

The accepted view as to how this deturgescence comes about and is maintained in a tissue literally surrounded by fluid is that the corneal epithelium is a semipermeable membrane which does not allow the passage of salts; and that it is in contact with the precorneal fluid which is rendered hypertonic by constant evaporation from its surface. As the fluid evaporates from the corneal surface water flows out from the corneal substance to restore the balance.[1, 6, 7]

The intake of fluid into the corneal substance is said to be from the canal of Schlemm. Plausible as this hypothesis is and supported by some experimental facts and constructive logic, the majority of authors agree that it fails to explain certain observed facts.

For instance, it cannot explain how the cornea remains clear during sleep when the lids are closed and there is no evaporation of tears, and hence no concentration of precorneal fluid. It does not explain what happens to the salts in the corneal substance; the assumption that the salts flow back into the canal of Schlemm is not very convincing.

On clinical grounds most of us have seen corneas denuded of their epithelium due to injury but with no evidence of corneal edema. We have also removed large areas of dead epithelium with alcohol, as a therapeutic measure for dendritic ulcer, and the denuded area of the cornea has stayed clear; only the area immediately surrounding the ulcer has become opaque.

From what has been said it is obvious that simple osmosis through a semipermeable membrane is not the whole story of corneal deturgescence and edema.

In the past decade or so the more extensive use of contact lenses has focused attention on the behavior of the cornea. It was found by Dallos in 1946[5] that nonfenestrated contact lenses produced an opacification of the cornea after being worn for varying periods. In consultation with Sattler he arrived at the conclusion that the opacity was due to an edema of the epithelium caused by the noxious action of the fall in pH of the precorneal fluid as a result of the absorption of $CO_2$ exhaled by the cornea. To counteract this fall in pH two methods were used, namely, use of a buffered solution to prevent such a fall in pH and perforation of the lens to allow a free exchange of air and precorneal fluid.

More recently Smelser and Ozanics[10, 14] demonstrated ice crystals in the stroma of the cornea in guinea pigs after producing corneal opacity with contact lenses and freezing the corneas rapidly, thus proving conclusively that the opacification of corneas due to contact lenses is a true corneal edema.

Ascher[2] has put forward an explanation of this edema, saying that it is due to a pressure on the aqueous veins and is a result of a back flow of fluid from the canal of Schlemm into the cornea.

## III. Present observations and experiments

During the past six years I have been fitting contact lenses and so have been interested in the behavior of the cornea. During this time I have observed the following points directly and experimentally concerning the behavior of the cornea:

1. That corneal haze and edema can occur with contact lenses in which the precorneal space is in free communication with air and

in which there is no pressure whatsoever on the aqueous veins.

2. That the corneal haze or edema occurs in the following four stages as observed with a slitlamp:

a. A superficial epithelial haze;

b. A deeper haze extending into the substance of the cornea;

c. A deep opacity interspersed by dichotomously branching and interlacing lines;

d. A peau-de-orange condition of the cornea, first described by Dallos. The depressions are opaque and the elevations transparent.

3. The corneal edema may be found only in a part of the cornea and the four stages described can be found in the same cornea at the same time.

4. That there is a depression of corneal sensation in all cases of corneal edema. The depth of this depression as far as one could measure it clinically corresponds to the intensity of the edema. In this sequence it would be as well to bear in mind the depression of corneal sensation in corneal edema due to glaucoma.

5. The edematous cornea when treated with glycerine clears up fairly easily before the peau-de-orange state but takes very much longer to do so when this stage has set in.

6. Very slight alterations in the fit of the contact lens increase the edema-free wearing time of these lenses enormously.

7. To confirm the above observation gutters of 2.0 by 4.0 by 0.10 mm. were ground on lenses that could be worn for long periods—eight hours—without corneal edema, and it was found that edema of the cornea then supervened after wearing the lenses for relatively short periods.[11,12]

8. As it was felt at this time that the profuse nerve supply of the cornea may be a factor in the production of corneal edema, the corneas of successfully fitted patients, that is persons who could wear their contact lenses without edema for eight hours or more, were anesthetized with two-percent butyn solution and then the lenses were worn again. In every case corneal edema supervened within a relatively short time. Butyn was used because it has no effect on the corneal epithelium normally.[5]

9. After the experiment just described it was considered that, if the nerves were the primary or main factor in the incidence of corneal edema, the corneal opacity in neuroparalytic keratitis should be an edema, that is, a keratosis and not a keratitis. Three eyes in two recent cases of neuroparalytic keratitis were fitted with contact lenses containing two-percent saline solution with ephedrine, the solution being renewed every two or three hours. The opacity cleared up completely leaving a very slight residue. Vision improved from about 6/60 to 6/6 and the eyes have remained like this with the treatment maintained.

From these observations the very important role of corneal nerves in the production of corneal edema was considered to be established.

## IV. Relevant basic properties of nerve fibers

To understand the mode of action of the nerves I must now recapitulate some of the basic properties of nerve fibers.

*Adaptation of a nerve fiber.* According to Hodgkin and Katz,[8,9] during the process of adaptation to a natural stimulus, the membrane of a nerve fiber becomes relatively permeable to sodium ions and there is a flow of ions into the nerve fiber from the surrounding fluid, that is, the surrounding fluid becomes ionized.

*Narcosis or injury to nerve fibers.* When a nerve is narcotized or injured, the affected part, when stimulated by the arrival of an electronic wave, responds with a subnormal spike potential which is the least the nerve fiber can produce, so that a damaged nerve fiber will have to absorb more sodium ions to produce an identical result to that of a normal nerve fiber.[15]

In other words, there will have to be a greater ionization of the surrounding fluid.

## V. Discussion and recapitulation of the points made

1. Anatomically the cornea is very rich in demyelinated nerve fibers, as compared to the sclera (section I).

2. When hydrated or rendered edematous, the cornea becomes opaque (section II).

3. The corneal nerves play a very important role in corneal edema (section III).

4. Stimulation of corneal nerves and their adaptation should cause an increase in the ionization of the fluid in the surrounding tissues, and narcosis of or injury to the nerve fibers should do the same (section IV).

We know that ionization means an increase in the osmotic pressure of a fluid, and it is thus conceivable that stimulation of the corneal nerves increases the osmotic pressure inside the cornea and a flow of water into the cornea from the surrounding fluids takes place. In normal circumstances, an equilibrium is maintained by the normal activity of the nerve fibers coupled with an osmotic equilibrium through the semipermeable epithelium. This hypothesis to my mind explains all the diversities of corneal behavior.

The branching opaque lines, mentioned in Section III (2-c) and clinically observed in cases of corneal edema due to causes other than contact-lens wear, are the water-logged nerve fibers and not temporary lymph channels as assumed by other observers, because the ionization and edema must be more marked at and proceed centrifugally from the nerve fibers that produce the change.

I am investigating this hypothesis further to the best of my extremely limited sources and would be grateful for any criticism and remarks.

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I wish to express my gratitude to my wife, Dr. Margaret Ford, for her help and encouragement; to Mr. Hatfield Wright and the consultation clinic of the Eye Hospital at Oxford for the two cases of neuroparalytic keratitis, and to the authors to whose work I have referred.

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# OCULAR DISEASES CAUSED BY NEMATODES

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## Introduction

This study was conducted in the Nilgiri mountains of South India, with the assistance of Dr. L. Herlufsen, Dr. Margaret Brand, and Miss Monica Sutton. It was inspired by two cases in which chronic eye complaints had been of two years' duration and had cleared up in a couple of days after receiving worm treatments. The first case was one of severe recurrences of phlyctenular keratoconjunctivitis, and the second case was one of chronic catarrhal conjunctivitis.

## Initial case

### Case 1

An Indian Moslem girl, aged nine years, was seen off and on for two years, during which time phlyctens came and went in both eyes, regardless of local remedies. The Moro (tuberculin patch test) had been negative, and therapeutic tests for syphilis and cod-liver oil therapy brought no results. Recurring attacks, during which one ulcer might heal while another was forming, finally left permanent scars in the left cornea, with some impairment of vision.

Laboratory tests, done only after two years of treatment, showed ascariasis. After the patient had passed 20 roundworms and had negative stools, her eyes cleared up in two days' time. She was free from symptoms for four years. Then suddenly she had another severe attack of eye trouble and was found to be positive for roundworm again. Again she cleared up promptly with treatment, although small corneal scars were left.

### Case 2

An adult man complained of watering eyes and redness for two years, in spite of having his glasses changed twice. After being treated for roundworms, in two days' time his eyes quieted down. When last seen, two years later, he had had no more trouble with his eyes.

## Part I. Study of nematodes and eye diseases

These two cases drew my attention to a possible connection between nematodes and eye diseases, and resulted in the study of 1,217 cases carried out between July 1, 1945, and July 1, 1947. These patients all had physical examinations and stool tests; 281 of them had blood counts to ascertain eosinophilia and incidentally to look for malaria. The report on the 1,217 cases, prepared for publication in 1948, was held up for further investigation of the complication of possible positive tuberculin tests.

It has long been known that phlyctenules may be associated with a tuberculous diathesis, but no mention of any connection between nematodes and phlyctenular pathology was found in the literature except for one little paragraph in an abstract in The American Journal of Ophthalmology (**35**: 1382, 1952) from a doctor who had had two cases of phlyctenules clear up as soon as the patients were treated for Oxyuris vermicularis and Trichiuris trichiura.

In the first series of 1,217 patients studied, 50 were not hospital or dispensary patients, but "sweeper caste" (scavenger caste) children in a village school. Because they had not come to the hospital they were selected as a "control group" to see what eye and worm combinations could be found in a group that had not made any complaints. This caste was particularly selected because of the occupation of the parents, who handle disposal of night soil, and because of the location of their homes, which are in a valley into which many streams flow down over hillsides that are used promiscuously by the local population instead of sanitary latrines.

It was not surprising, therefore, that 94

percent of these children were found to have both nematodes and eye diseases; however, the predominant eye condition was mild xerosis. In addition a few had follicular conjunctivitis and one had catarrhal conjunctivitis. That there were no phlyctenules among them may not be surprising in view of the fact that the cases of phlyctenular conjunctivitis complicated with nematodes in the hospital series occurred practically always in adults or adolescent children but hardly ever in little children, such as those found in the village school.

In the study of the larger group in the first series—the hospital and dispensary patients—not only cases of nematodes with eye diseases, but cases of dysenteries, particularly E. histolytica, were also included.

Of all the Eye Hospital patients, 92.33 percent were positive for worms and/or dysenteries and for eye diseases. Of the 824 cases with positive stools, 77.9 percent had eye diseases and 22.1 percent had no eye disease. Of the 393 cases with negative stools, 13.5 percent had eye diseases and 86.5 percent had no eye disease. In other words, the majority of cases with positive stools had eye complications; whereas, the majority of cases with negative stools had no eye complications—which adds evidence.

### Symptomatology of nematodes

Ascaris and hookworm were the nematodes counted.

Among the 600 patients with nematodes, three fifths had roundworm and two fifths had hookworm infestation. Cases of "ground itch"—the symptom produced by the hookworm larva when it burrows into the skin of the foot if a person stands in the damp, infested soil where hookworm larvae have developed—were seldom seen. Hookworm, unlike roundworm, will not develop from ova into larval forms within the intestine, but only outside the body. It is not surprising, therefore, that the roundworm was more prevalent since it can do both. Hookworm larvae from the soil may burrow into the skin to gain entrance into the body and finally become hooked into the intestines, as the roundworm does not do; so the hookworm is more destructive in the human body, though both larval forms, once having gained access to the blood stream or lymphatics, can migrate to the lungs causing pneumonitis; to the liver, causing abscess and hematoma; to the gall bladder, causing jaundice. They may even enter the pancreas and kidneys causing pancreatitis and nephrosis or enter the glottis and gain access to the gastrointestinal tract to make their abode in the intestine.

In spite of this lengthy symptomatology, no mention is made in the textbooks of any connection with eye diseases. In the present study special emphasis has been placed on the allergic aspect of the patients having various combinations of eye disease, nematodes, and tuberculin tests.

From these studies, the general impression was gained that the nematodes usually affected the superficial tissues of the orbit, whereas the dysenteries may affect the interior of the eyeball more often and only in severe cases give rise to keratomalacia and xerophthalmia. Statistical breakdown showed this to be the case (table 1).

Thus Table 1 shows that just under 80 percent of these cases involved the superficial structures of the orbit, and 20 percent involved the deeper structures of the eyeball. But the percentage of nematodes in superficial eye cases was just under 79 percent and this is only a little more than nematodes in cases with pathologic alterations in the eyeball itself (about 74 percent).

A similar classification of cases in the years 1949 and 1950, covering 602 patients, positive for nematodes (hookworm and roundworm, 354) and for dysenteries (248 of E. histolytica), showed even less difference in the percentage of nematodes in superficial eye lesions (about 59.5 percent) as compared with nematodes with involvement of the eyeball (about 58 percent). We do note, however, that the highest incidence of

TABLE 1

OCULAR EFFECTS OF NEMATODE INFECTION AND OF DYSENTERY

*Group I. Superficial tissue involvement*

| | Ascaris | Hookworm | Dysentery (E. histolytica) |
|---|---|---|---|
| Phlyctenular keratoconjunctivitis | 46 | 35 | 21 |
| Early xerosis | 47 | 1 | 5 |
| Catarrhal conjunctivitis | 34 | 19 | 15 |
| Blepharoconjunctivitis, hordeola, chalazia, sacs | 14 | 7 | 8 |
| Corneal ulcers with keratitis and staphylomas | 21 | 22 | 16 |
| Xerophthalmia and keratomalacia | 10 | 5 | 10 |
| Angular conjunctivitis (Morax-Axenfeld) | 9 | 6 | 4 |
| Flask-gland conjunctivitis (Lt. Col. R. E. Wright) | 2 | 2 | 1 |
| Follicular conjunctivitis | 8 | — | — |
| Pterygia | 6 | 5 | 2 |
| Purulent conjunctivitis (5 were gonorrheal) | 5 | 1 | 1 |
| Specific etiology | | | |
| Trachoma | 1 | — | — |
| Rhinosporidium of Seabury in conjunctival cul-de-sac, one case having both roundworms and hookworms | 1 | 1 | — |
| GROUP I. TOTAL—391 | 204 | 104 | 83 |

*Group II. Involvement of deeper structure (eyeball)*

| | Ascaris | Hookworm | Dysentery |
|---|---|---|---|
| Cataract | 18 | 15 | 14 |
| Glaucoma | 3 | 3 | 1 |
| Iritis and iridocyclitis | 4 | 9 | 6 |
| Retinitis and retinochoroiditis | 6 | 6 | 1 |
| Phthisis bulbi and panophthalmitis | 3 | 1 | — |
| Vitreous opacities | 1 | 1 | 5 |
| Optic atrophy | — | 1 | 1 |
| GROUP II. TOTAL—99 | 35 | 36 | 28 |

nematodes occurs in cases of superficial eye lesions and the incidence of E. histolytica infection is about the same, although the difference between the two types of involvement is not so great for the E. histolytica as for the nematodes.

## CONCLUSION

The allergic reactions to nematodes occur more often in the lids, conjunctiva, and cornea than within the eyeball.

As shown in Table 1, the most common superficial involvement with nematodes is phlyctenular keratoconjunctivitis, which is the type most generally regarded as allergic.

## PHLYCTENULAR OPHTHALMIA

Phlyctenular ophthalmia has been considered an unsolved problem since the days of Susruta, a Hindu called "the world's first surgeon," living over 1,000 years before Christ. It is usually considered due to tuberculin sensitivity, not from tuberculous disease but from tuberculous infection giving rise to sensitivity (Sorsby).

This is significant in view of the fact that my first ocular case with nematode—the young Moslem girl—was negative to the Moro (patch test) for tuberculin sensitivity. Likewise, it was noted that the phlyctenular and catarrhal eye cases with nematodes cleared up speedily after worm treatment in contrast to the tuberculin-positive cases.

In the literature, Besso and Dazy seem to be the only ones to suggest a possible "ailmentary intoxication" connected with phlyctenules. However, Duke-Elder dismisses this, along with various other suggested complications, as "merely incidental debilitating factors predisposing to the development of any disease but incapable by themselves of producing the specific phlyctenular lesion" (Duke-Elder: *Textbook of Ophthalmology*, volume 2, page 1687).

Since Belding has proven that Ascaris is capable of producing allergic symptoms, such as asthma, hay fever, urticaria, and eosinophilia (Belding: *Textbook of Parasitology*, page 322), it would hardly seem beside the point to add the phlyctenule-complicating nematodes to the list of allergies. The fact that man has been known to develop supersensitivity and even full immunity to *Ascaris*, as well as to hookworm, is evidence of the absorption of proteic products of the parasitic nematodes. And the fact that "specificity can be demonstrated by proper desensitization" is added evidence of specific supersensitization to the various nematodes, or to their proteic products (Belding, pages 246-247, 323).

Duke-Elder, along with Sorsby, considers the majority of the cases of phlyctenules to be the result of hypersensitivity to tuberculoprotein because of the "scrofulous or strumous" diathesis. Duke-Elder quotes Sorsby as saying (1936) that there is a connection between phlyctenules and tonsils or sinus disease, and so forth; and that it is noteworthy that the sensitizing agent is endogenous and bacterial; exogenous proteins, such as pollens, play no part in the etiology.

These authors may be thinking of the lodging of pollens in the conjunctiva but, as pollens tend to be washed out with tears, one may argue that it is a different proposition from having in the intestines foreign proteins whose main business is assimilation of the intestinal contents! One could argue that if the sinuses can absorb allergy-producing proteins, how much more likely would the intestinal tract be to absorb them! Belding not only discusses the production of toxic substances by ascarides, but also the supersensitiveness of the human body to Ascaris.

### Process of sensitization

Furthermore, Belding (page 322) says: "The production of definite toxic substances by Ascaris is still unsettled," but he goes on to say, "these extracts are hemolytic (Fishback, H. R., 1930; Herrick, C. A., and Emery, F. E., 1929), have an antipeptic and antitryptic action (Sang, J. H., 1938), and affect unfavorably the growth of fibroblasts in vitro (Hoeppli, R., 1935). Like histamine they increase the peristaltic action of the intestine, lower the blood pressure, deepen the respirations, decrease the volume of the spleen and liver, and irritate the skin and respiratory passages (Emery, F. E., and Herrick, C. A., 1929). Intravenous inoculations produce a fatal histamine type of anaphylactic shock in guinea pigs (Macheboeuf, M., and Mandoul, T., 1939). Immune serum neutralizes these toxic properties.

"Specific antibodies, such as precipitins and anaphylactins, may be demonstrated in infected animals and in those receiving injections of antigens. Various alcoholic and aqueous extracts of the whole or parts of the worm (Ascaris) have been used as antigens, and a polysaccharide antigen, which is claimed to produce specific antibodies, has been prepared (Campbell, D. H., 1936). . . .

"Supersensitiveness to Ascaris is not uncommon and manifests itself by the usual allergic symptoms of asthma, hay fever, urticaria, and eosinophilia. Recurring attacks of urticaria in a mother when her son suffered from Ascaris infection have been reported (von Fellenberg, R., 1932). Anaphylaxis can be produced in guinea pigs sensitized by injections of antigens and passive anaphylaxis can be demonstrated." (Belding, pages 322-323).

But it may be noted that even these various and detailed descriptions don't refer to eye disease.

### Resistance

Reference to eosinophilia as allergic does not displace it from the ranks of the immune processes in the human body. Belding clearly states that supersensitiveness is a part of the immunizing process in the host.

"Resistance," says Belding (page 245), "depends upon the pre-existing or acquired incompatibility of the host to the parasite

and upon the toleration of its effects. Immunity is acquired through the invasion of the tissues by the parasite and its larvae or through the absorption of its products, but is infrequently evident in purely intestinal species. . . ." (He discusses other species found in the rat.) Continuing with the human host:

"The local formation of precipitates immobilizes the worms, retards their development and migration, and sometimes destroys them. These antigen-antibody combinations localize the irritating excretions and secretions of the worm and inhibit its physiological activities. The immobilized worms are surrounded by nodular inflammatory reactions with lymphocytes, monocytes, polymorphonuclears, eosinophils, and often edema and hemorrhage. Dead worms are removed by the macrophages and giant cells. Eosinophils, which appear late in the immune reaction, are probably associated with the detoxification of foreign proteins and form a barrier to absorption."

Referring to the view advanced by A. C. Chandler in 1937, Belding (page 245) says that "immunity to nematodes is of two types: (1) Intestinal and (2) Parenteral. The former does not produce antibodies, but inhibits growth and reproduction by retarding the nutrition of the parasite through local antienzymes or precipitates."

## Part II. Studies of eosinophilia with nematodes

Of the first series of 1,217 cases, we obtained blood counts in only 281 and, of these, only 80 had more than one blood count done (many of the patients never returned for the follow-up tests). These 80 cases with more than one blood count are classified in Table 2.

The counts in Table 2 were taken on patients having both roundworm and hookworm, or else having one or the other alone, and having some eye disease along with the nematodes.

Another series of counts on a group which was negative for both eye affections and nematodes showed comparatively little fluctuation from count to count. Five of these all-negative cases had eosinophils of less than six percent and four had eosinophils between seven and 13 percent only. Moreover, though the "median" eosinophilia percentages for all groups, both the infested and the negative controls, were tabulated, yet doctors hardly ever are found to agree on a "normal eosinophil count." In Table 3, the "normal" of the eosinophil counts has not been named, not only because of the difficulty of knowing what is normal, but also because of a big margin of error due to the very uneven distribution of eosinophils on any one slide. Mr. R. M. Barton did research on this subject at the Tuberculosis Sanatorium at Arogyavaram, South India, and discovered that repeated counts on the same slide could give a variation as high as seven-percent eosinophilia because of the uneven distribution of eosinophils.

To eliminate another margin of error, instead of calculating the "average" for

TABLE 2

Classification of 80 cases with more than one blood count
(In percentage of total number)

| Group | Eosinophils | Count Dropped | Count Stable | Count Rose | Count Fluctuated During Treatment |
|---|---|---|---|---|---|
| I | 0– 6.5% | 9 | None | 18 | 9 (2 had 6 counts) |
| II | 7–11.5% | 12 | None | 7 | 8 (4 had 3 counts)<br>(1 had 6 counts) |
| III | 12–32.5% | 6 | 1 | 6 | 4 (1 had 5 counts)<br>(1 had 6 counts) |

TABLE 3

EOSINOPHILIA STUDIES

(Taken from the initial blood counts in the 281 cases studied)

| Group Number and Eyes and Worms* | Number Patients in Each Group | Eosinophilia (max.) Two Cases Highest % Counts (percent) | Patients with more than 13% | Median Count (percent) | Possible Error† (percent) |
|---|---|---|---|---|---|
| 1. E−RW+ | 64 | 22–25 | 8 | 5.6 | 4.2 |
| 2. E+W− | 26 | 19–20 | 3 | 5.7 | 3.7 |
| 3. E+RW+ | 118 | 25–28 | 12 | 6.5 | 3.7 |
| 4. E+RW+HW+ | 35 | 28–33 | 7 | 9.2 | 3.2 |
| 5. E+HW+ | 22 | 19–22 | 7 | 11.0 | 3.0 |
| 6. E−HW+ | 3 | | Too few to calculate | | |
| 7. E−RW+HW+ | 3 | | Too few to calculate | | |
| 8. E−W−‡ | 11 | 10–13 | None over 13% | 7.0 | 3.0 |

* E = eyes; RW = roundworms; HW = hookworms.

† Possible error in quartile deviation.

‡ This group is likely to be misleading for reasons given in the text.

comparisons, the "median" for each group has been calculated, since this is regarded as more representative of the group.

One group (8 in Table 3) gave a surprising result. In this group (8) without worms and without eye affections, just as one might expect, the maximum two counts were lower than the maximum of any other group; yet, when the medians are considered, they are found to be higher than the eosinophil median percentages of three other groups. However, this group can be discounted because (1) there were fewer cases tested than the other three groups and (2) though they were classed negative for both eyes and worms, it does not mean that they could not have some other infection producing allergy and eosinophilia. Infected sinuses and ears may have raised the allergic responses in the cases of this group (8, Table 3) moderately but perhaps consistently. An enormous number of cases showing negative eyes and negative worms could have been added if patients outside of the EENT department had been included. By adding general medical cases, we would have made the negative control group more reliable in our study than the 11 cases herein recorded.

Other possible sources of error which should be taken into consideration in the study of eosinophilia—the possibility of the presence of the complication of "tropical eosinophilia" or "the eosinophilic lung," and the wide fluctuation in successive counts which we found in individual cases—will be dealt with at length now.

## OTHER MARGINS OF ERROR

### 1. CHEST COMPLICATIONS

As already indicated, since this study has been conducted entirely in the tropics, the possibility of the presence of "tropical eosinophilia" or "eosinophilic lung" being present to influence the eosinophil count, must be considered, especially in view of the fact that both hookworm and roundworm can also give such lung complications as pneumonitis. Although no X-ray examinations were made to rule out "eosinophilic lung," only nine cases showed chest complications; six of these had eosinophil counts *under* four percent. In the three cases in which the count did run over this, the findings were as follows:

a. Nine-percent eosinophilia in a case of bronchitis with phlyctenular conjunctivitis and both roundworms and E. histolytica dysentery.

b. Ten and one-half-percent eosinophilia in a case of bronchopneumonia, with roundworms and phlyctenular keratoconjunctivitis. In this patient, the blood count rose to 13.5 percent eosinophilia immediately after treat-

ment, and then dropped down to 0.5 percent while convalescing.

c. Nineteen-percent eosinophilia in a case of bronchitis with negative eye pathology and negative stools.

2. Study of "medians"

Comparing the two highest counts in each group (table 3) with the medians, it looks as if there were discrepancies; for instance, though the lowest maximum eosinophil counts come, as one might expect, in the all-minus group; and the highest two percentages are in the all-plus group (eyes plus and hookworm and roundworm both present) yet, when we examine the medians we find the all-minus median is higher than three other groups with roundworms, with or without eye involvement, and eye involvement without roundworms being present. This matter has already been explained in part. But it must also be noted that there must have been fewer variations in the all-minus group in order to have a 7.7 percent median and yet have no counts with over 13 percent; whereas, in the two lower (1 and 3, Table 3, RW +) groups, though in both the maximum eosinophils are between 22 and 28 percent, the medians are less than the all-minus group. This seems to indicate that many more of the roundworm group show lower levels of eosinophil counts in spite of the few high counts.

It should also be noted that the groups showing only roundworms (1 and 3, Table 3) have lower medians than the group (4) having both types of worms and positive eye findings, suggesting that the presence of hookworm may induce a higher eosinophilia than the presence of roundworms alone. In the group (5) showing positive eye findings and hookworms only, the higher median seems to support the idea of hookworm being more constantly likely to produce eosinophilia than roundworm. On the other hand, it is surprising to find that the percentage of eosinophilia in the maximum percentage bracket is much lower for hookworm alone than for roundworm. This means that the distribution of hookworm percentages in the different brackets is much more even than that of roundworm. This is actually the case, for in our series, there were 15 cases of roundworm that showed no eosinophilia, or only one percent; whereas there was no case of hookworm that had a percentage that low. Again, 105 of the group with roundworms alone fell under seven-percent eosinophilia, and for hookworm the maximum number fell in the 10 to 13 percent eosinophil group.

These facts lead to the supposition that a large roundworm infestation can be present without producing eosinophilia; whereas, the reverse is true of hookworm. This is also supported by the eye findings. Of the "hookworm-alone-positives," there are seven times more cases with eye disease than without; whereas among the "roundworm-only" positives, eye disease was found in less than half. Though hookworm occurs much less frequently in the Nilgiris, when it does occur, it seems to be three times more likely to cause allergic symptoms (according to the eosinophil and eye-disease indicators of allergy).

In view of these findings, Belding's (page 295) summary in connection with hookworm is significant. He refers to allergic symptoms in Ascaris but gives this close scrutiny to hookworm:

"The leucocyte count is from 5,200 to 10,000 per cmm. (Saurez, R. M., 1933), but early infections may reach 17,000 (Smilie, W. G., and Spencer, R. M., 1926). Eosinophilia is irregular. The percentage is usually from 2 to 15 percent (Suarez, R. M., 1933) but during the early stages it may be as high as 55 percent (Smilie, W. G., and Spencer, C. R., 1926)."

Though Belding speaks of the high eosinophilia of 55 percent as coming early in the disease, in another place he speaks of it as coming late in the immune reaction. Certainly in the cases herein studied one could never tell whether the patient was being seen at an early or late date; for our patients

usually never have had a stool examination and most of them have had very little medical observation of any sort.

To summarize the comparison between roundworm and hookworm infestation in the present series of cases, it would seem that allergy from hookworm is more evident in both the eosinophil median percentages and in the maximum number of cases, as well as in the higher incidence of eye involvement in hookworm. This difference, in spite of the fact that roundworm is much more prevalent and exists as a much larger mass in the intestinal tract, may be because the roundworm lives off the food content of the intestine, as a rule, whereas the hookworm digs itself into the "trenches" and lives for years in the same spot feeding from the blood of the individual host. Also, the roundworm ova, in the gastro-intestinal tract, become much less of a menace than the hookworm larvae in the soil which burrow into the skin of the feet and migrate through the bloodstream, lungs, lymphatics and gullet before they find the "real estate" on which they will dig their foundations. It seems logical, therefore, that the body should develop more hypersensitivity and more immunity, later on, to hookworm than to roundworm.

### 3. Variations in eosinophils during therapy

In the study of successive blood counts on the same patient while he was undergoing treatment for both eye disease and worms, there were some interesting findings. One case showed a progressive rise in eosinophilia after treatment for roundworms was started. Another patient showed a sharp rise, with a later appearance of Oxyuris vermicularis and Trichiuris trichiura. This patient had one-percent eosinophils with roundworms; and later, after treatment for both hookworm and roundworm, again showed a low eosinophilia. In a third case which showed a sustained moderately elevated eosinophil count, with slight variations only, the patient suffered a long illness with serious systemic complications which aggravated both roundworm infestation and eye symptoms. A fourth case with hookworm showed a rise in eosinophilia after treatment.

#### Typical cases with complications

*Case 1.* M. J., a five-year-old Indian Christian Malayalee boy, had the diagnosis of phlyctenular keratoconjunctivitis complicated by roundworms. The eye disease had been present for one year. His condition improved while he was undergoing treatment elsewhere on the plains but still recurred when he returned to the hills. Table 4 shows the data in his case.

*Case 2.* The age of this grandmother (R) was not known. She cleaned at the hospital. The diagnosis in her case was pterygium (not inflamed), roundworm, hookworm, cystitis, and malaria. Patients in our clinics usually have more than one diagnosis. The findings in her case are reported in Table 5.

The pterygium remained quiescent throughout the period of observation. The appearance of a high eosinophilia, when Oxyuris vermicularis and Trichiurus trichiura were present and not with hookworms and roundworms, raises the question of the possibility that the first two nematodes produced the allergic condition. Perhaps this case should have been excluded from the present study which is primarily concerned with roundworm and hookworm. However, the case has significance in view of two similar cases of Oxyuris vermicularis and Trichiurus trichiura associated with phlyctenules which cleared as soon as the worm infestation was treated (Am. J. Ophth., 35: 1382, 1952).

*Case 3.* A teen age youth was acutely ill with Banti's disease with severe anemia, enlarged liver and spleen, roundworm, gastric hemorrhages, keratomalacia (severe), and eosinophilia. On six successive counts, the eosinophilia showed 9.5, 12, 10.5, 12, 8.5, and 12 percent. When the patient's eye condition showed most improvement, the eosinophil count was 12 percent; and when the

TABLE 4

FINDINGS IN CASE 1

| Date | Eye Condition | Hemoglobin (percent) | Eosinophils (percent) | Stools | Results and Treatment |
|---|---|---|---|---|---|
| 9/27/45 | Phlyctenular keratoconj. | 60 | 4 | RW | Worm—13 RW passed |
| 10/13/45 | Clear 2 da. after RW treatment | | 5 | Neg. | No treatment |
| 5/ 5/46 | Recur itching and burning | | 12 | RW | |
| 4/ 6/46 | | | | Passed 7 large RW | Worm treat. passed 7 RW |
| 4/12/46 | Free from symptoms | | 23 | Neg. | No treatment |

condition was at its worst, the count was still 12 percent.

## CONCLUSION

From these case reports, it seems apparent that there is no fixed relationship between the eosinophil count and the degree of infestation with nematodes, or the variety of nematode infestation, or the complicating systemic disease.

## PART III. STUDY OF OTHER COMPLICATING FACTORS

In addition to the margins of error appearing in this study of the relationship between eosinophilia, nematode infestation, and eye disease, there are other complicating factors which affect the diagnosis and prognosis in individual cases:

1. *Laboratory reports.* Stool tests may give false negatives. For example, one patient with a severe phlyctenular keratoconjunctivitis had a negative stool test. Again, with direct and floated specimens, the report was negative. Out of curiosity, the patient was given a worm treatment, and a total of 26 worms, the largest of which measured 12 to 18 inches, were passed.

Such misleading false negatives may not be due to faulty laboratory technique. Just what is in back of the problem is, however, as yet undetermined. It is known that misshapen or damaged roundworm ova may not float on saturated saline solution. Belding (page 245) refers to the inhibiting effect of the immunity of the host on the activities of the parasite: "It inhibits growth and reproduction by retarding the nutrition of the parasite through local antienzymes and precipitates."

One wonders whether, in the crowded, overpopulated gastro-intestinal tract of the patient here reported, there was too little room for reproduction and too little nutrition to supply enough vitality for the worms to reproduce. Or had Nature marshalled the antienzymes and other forces of reaction? Or is the worm susceptible to the reactions of supersensitivity and immunity?

2. *Variable dietary factors* complicate not only the response to treatment but the diagnosis itself. For example, it could not be determined in the short time available for observation, whether the xerosis of the school children of the sweepers' village was due to dietary deficiencies (which certainly cause xerosis) or to worm infestation.

Since there were no phlyctenules in the infected group (50 percent of the children), it was not possible to implicate diet more than parasites. It must be remembered, too, that the patients in this group were not sufficiently ill to seek aid at the hospital. Rather it was they who were sought out. And their eye complications were in the early, not the advanced, stages. Furthermore, even among the really sick children who were hospital patients, phlyctenular keratoconjunctivitis was rarely the eye diagnosis. Phlyctenular keratoconjunctivitis was usually found in adults, less often in adolescents, seldom in babies or young children of the age group found at the sweepers' village school.

TABLE 5

FINDINGS IN CASE 2

| Date | Eosinophil (percent) | Hemoglobin (percent) | Blood Smear | Urine | Stool | Treatment |
|---|---|---|---|---|---|---|
| 10/ 1/45 | 1.0 | 45 | Malaria neg. | WBC | RW | RW treatment |
| 10/ 9/45 | 4.0 | — | Malaria neg. | WBC | Neg. | Cystitis treatment |
| 10/23/45 | 1.5 | — | Benign Tertian Malaria | WBC | No. spec. | Cystitis & malaria treated |
| 2/20/46 | 60.0 | — | Neg. | Neg. | — | |
| 3/ 2/46 | 6.0 | — | Benign Tertian | — | — | Malaria treated |
| 5/ 3/46 | 14.0 | — | Malaria neg. | Neg. | Oxyuris & Trichuris | Treated worms |
| 5/23/46 | — | — | — | — | HW & RW | Treated worms |
| 6/27/46 | 2.0 | 80 | Benign Tertian | WBC+ | Neg. | Cystitis&malaria treated |

Diet can affect both the condition of the eyes and the infection from the worms. Belding (page 322) says: "Resistance in chickens is lowered by loss of blood and inadequate diet. Conflicting results have been obtained with A. lumbracoides in hogs, but it is the general concensus that vitamin-A deficiency lowers resistance to infection with ascarids."

The fact remains that in the present investigation, the eye complication cleared up with surprising rapidity a few days after treatment for worms. This could not have happened if the eye diseases had been due to dietary deficiencies. It may therefore be concluded that worms alone *may* be responsible for the eye findings.

3. *Later study.* There remained a small group of cases that did not clear up so spectacularly. For that reason the first series of studies was not published in 1948. It was desired to compare the phyctenular cases with cases in which there were positive tuberculin tests as well as in those in which the test was negative. A new series of cases has, therefore, been collected for study.

Again, and in this new series, a surprising variable factor presented itself. Since wide publicity had been given to the association of worm infection and eye disease, the incidence of phlyctenular cases in the Nilgiris had actually diminished. Whether the drop was due to the fact that members of the medical profession no longer regarded nematodes as benign, or whether some other factors helped to improve the situation cannot be determined. Although the number of cases in the second series of studies was limited, they were investigated and are here reported (table 6).

TABLE 6

FINDINGS IN 28 CASES OF PHLYCTENULAR KERATOCONJUNCTIVITIS SEEN FROM 1947 TO 1951

| No. Cases | No. Times Seen | Mantoux or Moro Tuberculin Tests | | | Eye Findings when Last Seen |
|---|---|---|---|---|---|
| | | Positive | Negative | Incomplete | |
| 1 | 1 | 1 | | | Healed |
| 6 | 2 each | 6 | | | Not healed |
| 3 | 3 each | | 3 | | Healed or improving |
| 9 | 5 to 10 each | 7 | 2 | | Not healed |
| 9 | 12 to 30 each | 4 | | 5 | Negative when last seen but all tests not finished |
| | | 18 | 5 | 5 | |

TOTALS: 28 patients; 21 seen 3 times or more.

## Part IV. Study of phlyctenular keratoconjunctivitis with tuberculin tests

For so long a time has the etiology of phlyctenular keratoconjunctivitis been considered established (associated with positive tuberculin sensitivity) that to introduce an alternative etiologic factor—nematodes—may be disturbing. Since the relationship between worm infestation and phlyctenular keratoconjunctivitis had never been investigated or even referred to (the only reference came later in 1952, Am. J. Ophth., **35**:1382), in so far as could be learned, this present study was undertaken in 1945.

In the end, the total number of cases collected were only 28. Many patients who started the tuberculin tests did not return, some not even to have the initial test read.

The Mantoux and Moro (skin-patch) tests were used but, with few exceptions, only one or the other test was used in any one case. Few patients returned for the third Mantoux injection; however, in most cases, the result was apparent prior to the third injection. The results in 28 cases of phlyctenular keratoconjunctivitis are shown in Table 6.

### Comment

In one case, the patient had been seen 30 times over a period of three and one half months. This case was not one of phlyctenulosis but resembled superficial punctate keratitis. The stools gave negative findings. The Mantoux test was negative to one unit but positive to 10 units. When the patient was last seen, the corneal scars were still present.

Another out-patient, observed over an eight-month period (seen a total of 17 times), had the diagnosis of recurrent flare-ups of phlyctenular conjunctivitis. The Mantoux test was strongly positive; the ankles were swollen; roundworms were positive. When last seen, this patient's eyes were still red in spite of worm treatment.

### Conclusions

In this portion of the study, the majority of patients (18) showed positive reactions to the tuberculin tests; five were negative and five incomplete. Out of the 18 positive tests, in only one case were the eyes healed when last seen. Of the five negative cases, the eyes had healed or showed marked improvement in three. However, the patients did not return for further check-up.

Among the tuberculin-positive cases, the patients tended to return over long periods of time; even so, in some cases, there was no healing when the patient was last seen.

From these observations, it seems possible to conclude that, in the majority of cases of nematode phlyctenular keratoconjunctivitis, healing takes place within a few days after worm treatment. Any flare-ups of the phlyctenulosis are due to reinfestation with nematodes. In tuberculous phlyctenular keratoconjunctivitis, on the other hand, the course is protracted and the results equivocal.

### Tropical phlyctenulosis

It seems important, in concluding this paper, to distinguish between tropical phlyctenulosis and tuberculin-positive phlyctenulosis. An editorial in the *Indian Medical Journal* (J. Indian M. A., **12**:84 [No. 3] 1942) described the etiology of phlyctenular ophthalmia as "still an unsolved problem, though the disease with its characteristic nodular lesion was recognized in the time of Susruta."*

The editorial discussed Sorsby's Hunterian Lecture (Brit. J. Ophth., **26**:159-189, 1942) and quoted Sorsby as referring to the problem of "the pseudo-phlycten of tropical countries" in contrast to the phlyctenular ophthalmia of a tuberculous diathesis. The editorial further quotes Sorsby, "The pub-

* Susruta was the great "father of Indian surgery" and the pupil of Dhabwabtarum, more ancient than Hippocrates and believed to have lived more than 1,000 years before Christ.

lished reports indicate a large incidence of the disease among adults and some histological evidence has been brought forward that the tropical phlycten tends to have an epithelioid structure." The editorial then comments that "there are hardly enough observations to accept the view that phlyctenuloses in tropical countries materially differ from those seen in Europe and the United States."

## Summary

1. Allergy has been attributed to nematodes and a "tropical phlycten" was suggested by Sorsby in 1942, but no reference appears in the literature connecting the allergic manifestation in phlyctenulosis with allergic symptoms produced by nematodes.

2. The possibility of such a connection was suggested by a case of phlyctenulosis that cleared spectacularly in a couple of days after worm treatment, though the phlyctenules had been recurring for two years previous to this. The patient then remained free from eye symptoms for four years, only to have another attack of phlyctenules with another roundworm infestation.

3. From 1945 to 1947, a study of 1,217 cases was made to determine the incidence of nematode infestation associated with eye disease.

4. A further study of 494 cases of eye disease with positive stool tests made it possible to classify the types of eye diseases which occurred with hookworm, roundworm, and histolytica, also known to produce pathologic conditions of the eye and the most common type of dysentery found on the Nilgiris, India, where this study was conducted.

As a result of this classification, it was found that the phlyctenular keratoconjunctivitis headed the list as the complicating eye disease both with nematodes and with amoebiasis. It was present in two thirds of all these cases. The ocular complications involved not only the superficial eye structures but less often the eyeball itself.

5. From a study of the eosinophilia, the following conclusions could be drawn:

a. The group negative for both worms and eye complications had the lowest maximum eosinophil count of any group.

b. The group with eye disease plus hookworms plus roundworms had the highest single maximum eosinophil count.

c. Hookworm was much less prevalent than roundworm on the Nilgiris, but eyes in patients infested with hookworm showed more moderate, more evenly distributed eosinophilia. Although in no cases of hookworm were eosinophils absent, the maximum range was from 10 to 13 percent; its maximum count 22 percent. On the other hand, there were 105 cases of roundworm out of 182 cases showing less than seven percent eosinophilia, 15 of the 182 cases had no eosinophils at all or less than one percent. The maximum single count, in the study was 28 percent eosinophilia.

d. These facts suggest that hookworm is a more constant factor in the production of allergic symptoms, perhaps due to the greater tissue destruction as it burrows its way through the skin of the feet and migrates through the lungs, blood, lymphatics, liver, and so forth and then anchors itself to the wall of the intestines. Roundworm is content to be a transient occupant of the lumen of the bowel and feed off the food ingested instead of the blood of the human host which is the food of hookworm. Roundworm *may* produce severe allergic manifestations or, more often, none at all; in many cases, the eye manifestations were the only symptoms of allergy, even in the absence of eosinophils.

6. Moro or Mantoux tuberculin tests in 28 cases of phlyctenulosis showed delayed healing of the eyes in the majority of tuberculin-positive cases, even after the worms were treated, in contrast to quick healing if the phlyctenules were due to nematodes alone.

Results in the groups of negative and incomplete tuberculin-tested patients were naturally unreliable. It was impossible to be

sure in the unhealed negative-tuberculin cases whether they would have proven to be positive had the patients all come back for the final stronger inoculations of tuberculin.

It should be emphasized, however, that in the first large series of cases studied, most of the phlyctenulosis cases cleared promptly when treated for worms and only recurred at those times when the patients were again found to be positive for worms.

# CORRELATION BETWEEN PHYSIOLOGIC AND CLINICAL ASPECTS OF EXOTROPIA*

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In contrast to the well-organized and voluminous literature concerning the subject of esotropia, the body of knowledge concerning divergent strabismus is meager in extent and confusing in organization. Much of this disorganization stems from the fact that the terminology pertaining to the various types of divergent squint is loosely applied and that the same term is used by different authors to connote different conditions. This may in part be due to authors taking their experiences in esotropia and applying them to their study of exotropia; whereas, actually, esotropia and exotropia are not comparable entities from the points of view of incidence, clinical manifestations, and treatment.

It is the purpose of the present study to define the position held by divergent squint within the general field of strabismus, to elucidate certain salient clinical features of the different types of exotropia, and to point out how this knowledge may aid in the management of divergent strabismus.

## PRESENTATION OF DATA

This paper is based upon a study of all cases of strabismus seen in the Department of Motor Anomalies of the New York Eye and Ear Infirmary from the year 1951 through the year 1953. Many of these clinic cases had been followed for several years prior to 1951 and many are seen at frequent intervals in the department. Our series is based on the study of 1,431 patients, of whom 1,107 had esotropia and 324 had exotropia (table 1). We have limited our series to "primary" strabismus and have eliminated all cases which had (1) manifest paralysis of a single or of several muscles, (2) atypical Duane's syndrome, (3) exotropia resulting from surgical correction of a primary esotropia, and (4) cases in which the exotropia was obviously a minor part of a primary vertical motor anomaly.

## DEFINITION OF TERMS

When we attempted to group these 324 cases of exotropia in the light of accepted classifications of divergent strabismus, we found that great confusion in terminology shrouds the subject. Certain authors refer

TABLE 1

INCIDENCE OF EXOTROPIA AND ESOTROPIA

| | No. of Cases | Percentage |
|---|---|---|
| Exotropia | 324 | 22.6 |
| Esotropia | 1,107 | 77.4 |
| Total | 1,431 | 100.0 |

* From the Department of Motor Anomalies of the New York Eye and Ear Infirmary. Presented before the New York Academy of Medicine, Section on Ophthalmology, November 15, 1954.

to alternating and uniocular exotropia without differentiating whether the strabismus is constant or intermittent. Others refer to "divergence excess" and "convergence insufficiency" without reference to whether they are dealing with exophoria or exotropia.

The fact that some patients will at times show exotropia and at other times exophoria has given rise to a variety of phrases which purport to describe the same condition but actually refer to several different clinical entities. Thus, the interchangeable use of the terms "intermittent exotropia," "periodic exotropia,"[1] "divergence excess," "divergence excess with secondary convergence insufficiency," "neuropathic exotropia,"[2] "occasional exotropia,"[3] "exophoria-exotropia," "the exotropia of inattention" merely tends to add to the confusion with regard to terminology.

The subject is further muddled because different authors use the same term to refer to different types of cases. Thus, Bielschowsky uses "periodic exotropia" to denote that deviation which is at times manifest and at other times is latent; the same term is used by Duke-Elder[4] to refer to that exotropia in which the degree of dissociation varies with the distance of the fixation object from the eyes.

A further example of a single term used in different senses is "intermittent exotropia": it is used by Knapp[5] to refer to "divergence excess," the criteria of which were defined by Dunnington[6]; whereas Scobee[7] describes it as a "condition characterized by moderate to marked degrees of exophoria lapsing into frank exotropia with inattention, fatigue, or prolonged use of the eyes for close work."

After thorough study of the 324 cases of comitant exotropia, it became evident that the cases fell into certain natural groups. Consequently, we have adopted the following classification to cover all varieties of comitant exotropia:

I. Intermittent exotropia

II. Constant exotropia
   A. Constant alternating exotropia
   B. Constant uniocular exotropia

We have elected to retain in use the term "intermittent exotropia" because it best fits that group of patients which shows both exophoria and exotropia. Because of the looseness attendant to the use of the term in the past, we have applied the term "intermittent exotropia" to those cases which have the following characteristics:

1. At times the patient shows a manifest divergent strabismus.
2. At least part of the time the patient has exophoria, orthophoria, or esophoria.

We specifically define "exophoria-exotropia" as that type of intermittent exotropia in which, for any given distance of the object of fixation, the patient will at times show frank exotropia while at other times he will show an exophoria of approximately similar degree. Since it is the custom of most ophthalmologists to examine patients with squint by measuring the deviation with the patient fixating a light at six meters and 25 cm., we have followed the same procedure and thus have both distance and near measurements for each patient.

Theoretically, there are seven different groups of cases which fulfill these criteria for intermittent exotropia, and a review of our series reveals that, indeed, there are patients in every category.

*Group*

1—Exotropia for distance (XT)
Exophoria, orthophoria or esophoria for near (X′, O′ or E′);

2—Exotropia for distance (XT)
Exophoria-exotropia for near (X′-XT′);

3—Exophoria-exotropia for distance (X-XT)
Exophoria or orthophoria for near (X′ or O′);

4—Exophoria-exotropia for distance (X-XT)
Exophoria-exotropia for near (X′-XT′);
5—Exophoria or orthophoria for distance (X or O)
Exophoria-exotropia for near (X′-XT′);
6—Exophoria-exotropia for distance (X-XT)
Exotropia for near (XT′);
7—Exophoria or orthophoria for distance (X or O)
Exotropia for near (XT′).

These seven subgroups have been used in an attempt to get more specific comparative information about the different groups of cases. They are naturally occurring groupings based on two considerations: (1) The fact that the intermittency may be temporal, that is, for any given distance the patient may show exophoria or exotropia at different times; (2) the fact that the intermittency may be spatial, that is, the patient may show exotropia for one given distance of regard but exophoria or orthophoria for another.

Constant alternating exotropia is that category of cases which shows a constant divergent strabismus, with relatively equal vision in each eye and the ability to hold fixation with either eye, even though individual cases may prefer one eye for fixation.

Constant uniocular exotropia includes those cases of constant divergent strabismus which fixate with one eye only and are unable to hold fixation with the other.

## I. Intermittent exotropia

### A. General characteristics

Great stress has been laid on the definition of intermittent exotropia because an analysis of the cases of comitant exotropia reveals that 85 percent of such cases are intermittent in nature (table 2). Consequently, the key to the understanding of exotropia in general lies mainly within this group. With this in mind, we have analyzed our series of cases in an attempt to clarify the characteristics of intermittent exotropia.

The incidence of each group is shown in Table 3.

Group 1 constitutes 11 cases or four percent of our series. These patients show a constant exotropia for distance and, usually, exophoria for near. One isolated case had a slight esophoria ($8^{\Delta}$) for near. The deviation for near rarely exceeds $10^{\Delta}$, while that for distance ranges from $20^{\Delta}$ to $40^{\Delta}$; nevertheless, in more than one third of these cases the measurements for near approximated those for distance. The near-point of convergence (n.p.c.) is usually good.

Group 2 constitutes 41 cases or 15 percent of our series. It resembles Group 1 in that the deviation for distance is always an exotropia, but differs in that the deviation for near is an exophoria-exotropia. The deviation for near is usually of the same order of magnitude (within $5^{\Delta}$) as that for distance (56 percent) and, in the remaining cases, the same number of patients showed greater deviation for distance as showed greater deviation for near. In only four cases was the deviation for near less than $10^{\Delta}$. In general, the n.p.c. tended to be good in those cases in which the deviation was greater for distance than for near, and for those cases with equal deviation for distance and near; and it was relatively poor where the deviation for near was greater than that for distance. However, there were individual cases which did not follow the general rule.

Group 3 consists of 22 cases (eight percent) and was characterized by exophoria-exotropia for dis-

TABLE 2

Incidence of types of exotropia and esotropia

| | Exotropia | | Esotropia | |
|---|---|---|---|---|
| | No. of Cases | Percentage | No. of Cases | Percentage |
| Intermittent | 276 | 85.0 | 185 | 16.7 |
| Constant Alternating | 18 | 5.7 | 375 | 33.9 |
| Constant Uniocular | 30 | 9.3 | 547 | 49.4 |

TABLE 3

SUBGROUPS OF INTERMITTENT EXOTROPIA

| Subgroup | Characteristics | Symbols | Incidence | |
|---|---|---|---|---|
| | | | Number of Cases | Percentage |
| 1 | Exotropia for distance; Exophoria, orthophoria or esophoria for near | XT<br>X′, O′, or E′ | 11 | 4.0 |
| 2 | Exotropia for distance; Exophoria-exotropia for near | XT<br>X′–XT′ | 41 | 15.0 |
| 3 | Exophoria-exotropia for distance; Exophoria or orthophoria for near | X–XT<br>X′ or O′ | 22 | 8.0 |
| 4 | Exophoria-exotropia for distance; Exophoria-exotropia for near | X–XT<br>X′–XT′ | 115 | 42.0 |
| 5 | Exophoria or orthophoria for distance; Exophoria-exotropia for near | X or O<br>X′–XT′ | 82 | 29.5 |
| 6 | Exophoria-exotropia for distance; Exotropia for near | X–XT<br>XT′ | 2 | 0.6 |
| 7 | Exophoria or orthophoria for distance; Exotropia for near | X or O<br>XT′ | 3 | 0.9 |

tance, and exophoria or orthophoria for near. The deviation for distance ranged usually from 15$^{\Delta}$ to 35$^{\Delta}$, while that for near was usually under 15$^{\Delta}$ (16 out of 22 cases). With the exception of three cases in which the deviation was greater for near than for distance, there were equal numbers of cases in which the deviation was either greater for distance or equal for distance and near. In all cases (with three exceptions) the n.p.c. was very good (that is, under 60 mm).

Group 4 represents the largest number of patients. There were 115 cases (42 percent) in this category. These patients showed exophoria-exotropia both for distance and near. A comparison of measurements for distance and near is shown in Table 4. With the exception of the relatively few cases (17) in which there was a greater deviation for distance than for near, the remainder of these cases showed a relatively equal incidence of patients with greater or equal deviation for near as compared with distance. There was a wide scattering of values for near-points of convergence, and no clear-cut correlation between n.p.c. values and the amount of deviation for near could be demonstrated.

Group 5 is the second major category and consists of 82 cases or 29.5 percent of our series. These patients show an exophoria or orthophoria for distance, and an exophoria-exotropia for near. In almost all cases (80 out of 82) the deviation for distance measured 10$^{\Delta}$ or less, and 47 of these 80 showed orthophoria for distance (table 5). Most of the deviations for near (62 out of 82) were less than 20$^{\Delta}$, with only three measuring more than 30$^{\Delta}$. Thus, most of the deviations in this group were in the small-to-moderate range. In general, the greater the amount of near deviation, the more remote was the n.p.c.

Group 6 (exophoria-exotropia for distance and exotropia for near) and Group 7 (exophoria or orthophoria for distance and exotropia for near) contain too few cases to permit of characterization. Their importance lies in the very fact of their existence, since they had been predicted on the basis of possibility and were actually found.

TABLE 4

CORRELATION OF DISTANCE AND NEAR MEASUREMENTS IN SUBGROUP 4

| | | Deviation for Distance in Prism Diopters | | | |
|---|---|---|---|---|---|
| | | 0–10<br>No. of Cases | 11–20<br>No. of Cases | 21–30<br>No. of Cases | >30<br>No. of Cases |
| Deviation for Near in Prism Diopters | 0–10 | 2 | 2 | 2 | — |
| | 11–20 | 8 | 20 | 7 | 5 |
| | 21–30 | 2 | 10 | 14 | 1 |
| | >30 | 1 | 8 | 19 | 14 |

TABLE 5

CORRELATION OF DISTANCE AND NEAR MEASUREMENTS IN SUBGROUP 5

| | | Deviation for Distance in Prism Diopters | | | |
|---|---|---|---|---|---|
| | | 0<br>No. of Cases | 0–10<br>No. of Cases | 11–20<br>No. of Cases | 21–30<br>No. of Cases |
| Deviation for Near in Prism Diopters | 0–10 | 11 | 3 | — | — |
| | 11–20 | 29 | 19 | — | — |
| | 21–30 | 7 | 10 | — | — |
| | >30 | — | 1 | 2 | — |

B. AGE CHARACTERISTICS

In only 62 out of 276 cases of intermittent exotropia (22.5 percent) was it possible to elicit a stated history of age of onset of the strabismus. This may be due to the intermittency of the squint and the fact that signs of exotropia frequently pass unnoticed by the family. Many of our cases, especially those over 10 years of age, were sent to the Department of Motor Anomalies from the general clinic where they had consulted the ophthalmologist because of asthenopic symptoms and had no knowledge of squint until it was discovered during a routine examination. The paucity of accurate dating of the age of onset in exotropia is in sharp contrast to esotropia where, in the vast majority of cases, the patient or the parent has a definite idea of when the squint began.

Since our data on age of onset yielded such meager results, we have tabulated the patients ages at the first visit to the clinic. (table 6).

C. REFRACTIVE ERROR

The refractive error was measured in 256 of our 276 cases (93 percent). We have divided the cases into those with spherical errors in which there was no significant astigmatic or anisometropic element into those with an astigmatic element of 1.0 diopter or more, and into those with an anisometropic element of 1.5 diopters or more. In all cases the cycloplegic acceptance (or, in the case of infants, the cycloplegic retinoscopic finding) was used. The results are shown in Table 7.

There were 31 patients (12 percent) who showed astigmatism of 1.0 diopter or more, and the error has been included as their spherical equivalent for the purpose of comparison with norms of refractive error in the general population as quoted by other authors. However, our cases of anisometropia, which numbered only 15 (5.8 percent), have not been included. There was no case of anisometropia with more than 3.0 diop-

TABLE 6

AGE WHEN FIRST SEEN AT CLINIC

| Group | 0–1 | 1–2 | 2–4 | 4–6 | 6–10 | 10–20 | 20–40 | >40 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 5 | 2 | 2 | 0 | 0 |
| 2 | 0 | 2 | 3 | 11 | 13 | 9 | 1 | 1 |
| 3 | 0 | 0 | 4 | 3 | 10 | 0 | 4 | 1 |
| 4 | 2 | 0 | 11 | 21 | 33 | 24 | 16 | 5 |
| 5 | 0 | 1 | 2 | 1 | 16 | 27 | 28 | 6 |
| 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 7 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| Total Cases | 3 | 4 | 20 | 41 | 76 | 63 | 50 | 14 |

TABLE 7

REFRACTIVE ERROR

| | Myopia | | | | Emmetropia | | Hyperopia | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | > −3.50 | −2.50 | −1.50 | −0.50 | −0.25 | 0 | +0.25 | +0.50 | +1.50 | +2.50 | > +3.50 |
| Spherical | 9 | 8 | 8 | 21 | 10 | 28 | 22 | 68 | 25 | 7 | 4 |
| Astigmatic (Spherical equivalent) | 4 | 1 | 1 | 3 | 3 | 4 | — | 8 | 2 | 2 | 3 |
| Total | 13 | 9 | 9 | 24 | 13 | 32 | 22 | 76 | 27 | 9 | 7 |
| Percentage | 5.4 | 3.7 | 3.7 | 10.0 | 5.4 | 13.1 | 9.3 | 31.7 | 11.1 | 3.7 | 2.9 |
| Total % | 22.8 | | | | 18.5 | | 58.7 | | | | |

ters difference between the two eyes.

Although the incidence of refractive errors as quoted by other authors varies in the age group tested and the limits which divide myopia, emmetropia, and hyperopia, it is obvious that the incidence of the different types of refractive error in patients with intermittent exotropia is similar to that of the general population. We agree with Cass[8] and Bair[9] in stressing that there is no increased incidence of myopia in patients with intermittent exotropia over that of the general population. Moreover, one half of our patients showed a hyperopic refractive error (over +0.5 diopters), and there were more emmetropes than myopes among the remaining cases. The peak incidence of refractive error (31.7 percent) was found to lie between +0.5D. and +1.5D., and this corresponds to the figure of 33.3 percent of Brown and Kronfeld[10] for the adolescent group in the general population which corresponds most closely to the age group studied by us.

It is to be noted that all of the different groups of intermittent exotropia (with the exception of Groups 6 and 7, which do not comprise enough cases to permit of analysis) tended to show the same relative incidence of refractive errors, with a tendency to peak incidence between +0.5 and +1.5 diopters of hyperopia.

### D. Role of myopia

Since the accommodation-convergence theory of Donders postulates that the correction of myopia with glasses would stimulate accommodation, thus increasing convergence effort with the subsequent reduction of a divergent strabismus, we have examined our data to note the effect of the correction of myopia on the amount of strabismus. In 36 cases of myopia and exotropia where it was possible to obtain the amount of deviation with and without glasses, 75 percent showed no change in the deviation when the full myopic correction was worn. The refractive error ranged from −0.5D. to −15.0D., and five cases had more than −5.0D. of myopia. In the remaining 25 percent the myopic correction had its effect mostly on the near measurement, either by reducing the amount of deviation or by converting an exophoria-exotropia to an exophoria. In most of the cases aided by glasses the amount of refractive error was moderate, averaging about −3.5D. of myopia. The average amount of deviation corrected was $10^{\Delta}$.

The role of myopia in the causation and correction of exotropia has been grossly overemphasized, even by those authors who acknowledge that the relationship of myopia and exotropia is much less definite than the relation of hyperopia to esotropia. Our data reveal that myopia occurs in only 22.8 percent of patients with exotropia (the same incidence as in the general population) and that only 25 percent of those cases of exotropia with myopia show diminution of the amount of deviation on wearing the correction. Thus, merely some five percent of cases with intermittent exotropia are benefited by correcting myopia, and here the effect is mainly on the deviation for near.*

## E. Discussion

Our study of the seven subgroups was done in an attempt to derive answers to several questions:

1. At what distance can the patient maintain binocular simultaneous fixation?
2. Do most patients fuse intermittently for distance, for near, or for both?
3. Is the deviation greater for near or for distance?
4. Are the terms "divergence excess" and "convergence insufficiency" sufficiently well defined entities to permit categorization of individual cases?
5. How does the n.p.c. help in classifying individual cases?

The very fact that deviations of the ocular axes have been divided into heterophoria and heterotropia is based upon the ability of the patient to maintain parallelism of the ocular axes. It is for this reason that we have chosen this particular ability of the patient as the main criterion upon which to segregate patients into naturally occurring groups. We recognize the arbitrariness of dividing distance and near measurements into six meters and 25 cm., but have done so because of accepted ophthalmologic practice. Future investigation will be directed toward determining that point along the visual axes where the fusion mechanism is no longer adequate and where exophoria and exophoria-exotropia become frank exotropia.

A review of Table 3 reveals that 19 percent of our cases (subgroups 1 and 2) had constant exotropia for distance fixation, while only 1.5 percent (subgroups 6 and 7) had constant exotropia for near fixation. Thus, 79.5 percent of our cases at times showed the ability to maintain simultaneous binocular fixation for either distance or near, or for both.

Our largest single group (42 percent, subgroup 4) showed the ability to maintain simultaneous binocular fixation for both distance and near at least part of the time. Thirty-one percent (subgroups 1, 2, and 3) of the total 276 cases of intermittent exotropia showed less ability to maintain simultaneous binocular fixation for near than for distance, whereas 27 percent (subgroups 5, 6, and 7) showed more ability to maintain simultaneous binocular fixation for near than for distance. It is noteworthy, however, that when the ability to maintain fixation becomes weakened primarily for near, it is manifested in the overwhelming majority of cases by development of exophoria-exotropia; if the ability to maintain fixation becomes weakened primarily for distance, it usually results in frank exotropia.

We wish to point out an apparent paradox: While it is true that more patients show constant exotropia for distance as compared to near (19 percent vs. 1.5 percent), it is also true that a greater number are able to maintain constant parallelism of the ocular axes for distance as compared with those who exhibit constant parallelism of the ocular axes for near (29.5 percent vs. 12 percent, or subgroup 5 vs. subgroups 1 and 3). It would thus seem that maintenance of parallelism of the ocular axes in the primary position is more apt to be "all or none" for distance fixation than for near; that is, if present, it is more likely to be constantly present, or, if absent, to be totally absent; while for near, the ability to maintain parallelism of the ocular axes in the primary position is more likely to be present or intermittent, and very rarely absent.

Analysis of our 276 cases from the point of view of whether the deviation is significantly greater for distance or for near is shown in Table 8. If the deviations for distance and near measured within $10^{\Delta}$, they

* If a patient with myopia wears his full correction, he is emmetropic for distance and must accommodate for near. As a consequence of accommodation, the patient converges and this accounts for the improvement for near. Accommodation plays no role for distance; hence, convergence is not called into play. Thus, one would expect no effect of full myopic correction on the distance deviation.

TABLE 8

COMPARISON OF THE DEVIATIONS FOR DISTANCE AND NEAR

| Group | Distance Greater than Near (over 10Δ) | Distance Equal to Near (within 10Δ) | Distance Less than Near (over 10Δ) | |
|---|---|---|---|---|
| 1 | 9 | 2 | 0 | |
| 2 | 9 | 23 | 9 | |
| 3 | 10 | 9 | 3 | |
| 4 | 17 | 50 | 48 | |
| 5 | 0 | 3 | 79 | |
| 6 | 0 | 0 | 2 | |
| 7 | 0 | 0 | 3 | |
| Total Cases | 45 | 87 | 144 | 276 |
| Percentage | 16.0 | 31.5 | 52.5 | 100.0 |

were considered similar and were so recorded. These figures reveal that in 16 percent of cases the deviation was greater for distance than for near, in 31.5 percent of cases approximately equal for distance and near, and in 52.5 percent of cases greater for near than for distance.

This led us to examine our data to see whether our cases could be divided into divergence excess, convergence insufficiency, and "mixed" or "consecutive" cases (convergence insufficiency following divergence excess and vice versa). Among other criteria elaborated by Dunnington,[10] cases of divergence excess show a good n.p.c. A review of cases which have a greater deviation for distance than for near revealed that the n.p.c. in many cases was greater than 90 mm. Can one classify as divergence excess a case which shows 40Δ exophoria-exotropia for distance, orthophoria for near, but an n.p.c. of 100 mm.? Or, 10Δ exotropia for distance, 4Δ exophoria for near, and an n.p.c. of 120 mm.? Or, 30Δ exophoria-exotropia for distance, 10Δ for near, and an n.p.c. of 110 mm.? Are these cases of divergence excess with secondary convergence insufficiency?

We believe they are not, because, although the n.p.c. is remote, there is little or no deviation for near, hence no true insufficiency of convergence.

On the other hand, in pure convergence insufficiency one would expect the deviation for near to be considerably greater than that for distance and the n.p.c. to be remote. How, then, explain such typical examples from our files as orthophoria for distance, 25Δ exophoria-exotropia for near, and an n.p.c. of 70 mm.; or 5Δ exophoria, 25Δ exophoria-exotropia for near, with an n.p.c. of 30 mm.? Can such cases be classified as convergence insufficiency with secondary divergence excess? Again, these cases do not fulfill the criteria of this category since the distance measurement is within normal limits and the n.p.c. is good.

We do not deny the existence of certain cases which fulfill all the criteria set down by Dunnington as constituting divergence excess. Such "pure" cases, we believe, are in the minority. In many instances the ophthalmologist is faced with a set of data which he is frankly unable to categorize as convergence insufficiency or divergence excess or mixed. In our cases, 31.5 percent showed essentially equal measurements for distance and near. How is one to classify such cases? It is frequently impossible to classify such "mixed" cases as primary divergence excess with secondary convergence insufficiency or vice versa since the ophthalmologist rarely follows a patient long enough to watch a secondary deviation develop from a primary one, if such occurs at all.

We would stress, therefore, that the actual amount of deviation is not so important as is the presence or absence of fusion in the primary position because it is on this factor that the prognosis of both surgical and orthoptic treatment is based. We agree with Chavasse[11] who desires to "abandon the rather sterile, question-begging and clinically unsatisfactory classification of cases into (a) convergence insufficiency, (b) divergence excess, and (c) mixed (most cases). . . ." Therefore, we feel that it is important to study the individual case without placing it into an artificial category.

Each case should be studied from the

points of view of visual status, the presence or absence of suppression, the vergences, and so forth, and the treatment of each case should be individualized to counteract those factors which require correction, either by orthoptics or by surgery.

It is not sufficient to state, "This boy has divergence excess; he should be a good candidate for surgery," or, "This child has convergence insufficiency; she should do well with orthoptics."

In each case, whatever therapeutic regimen is adopted should be specifically directed toward overcoming those obstacles which prevent or hinder the development of normal fusional habits.

## II. Constant exotropia

Whereas 85 percent of our patients had exotropia which was intermittent in nature, 15 percent had constant exotropias (that is, they never manifested exophoria or orthophoria, either for distant or near fixation). These cases fell into two groups which differed not only in their manifestations but also in their etiologies, namely, constant alternating exotropia and constant uniocular exotropia.

### A. Constant alternating exotropia

The first group of constant exotropia is "constant alternating exotropia." We encountered 18 such cases or 5.7 percent of our series. In this group the vision was relatively equal in both eyes (within one line on the Snellen chart) and the patient could maintain fixation with either eye although he may have preferred to fix with one or the other eye. The refractive errors were moderate in amount although one third of the cases had astigmatism greater than 1.0D. There was no case of anisometropia of more than 1.5D. The measured deviations were generally of greater magnitude than those in which intermittency was present, and two thirds of the cases had a deviation of 30$^{\Delta}$ or more. In two thirds of the cases there was less than 10$^{\Delta}$ difference between the distance and near measurements.

### B. Constant uniocular exotropia

The other group of constant exotropia is "constant uniocular exotropia." The 30 cases in this category constituted 9.3 percent of our total series of exotropia. These cases show a constant exotropia and the patient can maintain fixation with only one eye. In most cases one eye had vision of 20/100 or less while the other eye had relatively normal visual acuity. In only six cases were we unable to find an obvious reason for the diminished vision. Twelve cases had anisometropia of 3.0D. or more, and three had anisometropia between 1.5D. and 3.0D.; seven cases showed a large vertical component but no obvious paresis of a single muscle; one case had a macular chorioretinitis, and one had a persistent hyaloid membrane. The six cases with no apparent cause for the diminished vision may well be cases of true "essential amblyopia." Nineteen cases were first seen at the clinic before the age of 11 years; their exotropia varied from 10$^{\Delta}$ to 90$^{\Delta}$.

### C. Discussion

It would seem that our group of constant uniocular exotropia consists of patients who for one of several reasons have diminished vision in one eye. The strabismus is thus probably secondary to the amblyopia.

Constant alternating exotropia, on the other hand, must be considered on an entirely different etiologic basis. These cases are essentially similar to those with intermittent exotropia except that they do not have enough fusion ability to manifest exophoria at any time. It is a commonly held belief that there is a progression in a large percentage of cases from exophoria to intermittent exotropia and finally to constant alternating exotropia. The fact that constant alternating exotropia constitutes only 5.7 percent of the cases, whereas intermittent exotropia is present in 85 percent, would

seem to indicate that if this progression takes place at all, it occurs in only a small percentage of the cases.

It should be underscored that one half of the 18 cases with constant alternating exotropia were first seen before the 10th year of life (seven reported onset before age three years). Thus, if progression through the above-postulated steps in exotropia took place in these cases, it must have occurred early and rapidly. On the other hand, there are a considerable number of middle-aged patients who have intermittent exotropia and never progress to constant exotropia.

Many of our cases of intermittent exotropia did not show any progression in the measured amount of their deviation nor did they tend to show diminished fusion ability. It is our belief that if it occurs at all, it is the rare case which progresses from an intermittent exotropia to a frank exotropia. In view of the fact that only patients with exotropia who have poor vision in one eye fall into the constant uniocular exotropia category, while those with intermittent or alternating exotropia have relatively good vision in both eyes, it is our contention that the ophthalmologist need not fear the development of any considerable amount of amblyopia in the usual case of exotropia.

### Comparison between convergent and divergent squint

We should like to point out that esotropia and exotropia differ fundamentally in many respects. They should not be considered as similar conditions which differ mainly in that in the one case the eyes turn in, and, in the other, out.

Convergent strabismus is approximately three times as prevalent as divergent strabismus. In our series (table 1), the divergent cases comprise 22.6 percent, whereas convergent cases comprise 77.4 percent. These figures are in essential agreement with other authors—Lagleyze[12] who found 17-percent exotropia and 83-percent esotropia; Cass[1c] who found 19 percent exotropia and 81 percent esotropia; and Bair[1c] who found 21 percent exotropia and 79 percent esotropia.

It is further interesting to compare the incidence of types on the basis of the classification proposed above. These figures show that in our series 85 percent of cases of exotropia are intermittent whereas 5.7 percent are constant alternators and 9.3 percent are constant uniocular exotropes. In esotropia, on the other hand, only 16.7 percent are intermittent, while 33.9 percent are constant alternators, and the greatest number, 49.4 percent, are constant uniocular esotropes.

Other authors (Nordlöw,[13] Lagleyze[1c]) quote figures which are in close agreement with our percentages concerning the incidence of intermittent esotropia. Thus, when one speaks of exotropia, it is to be remembered that the vast majority of cases will show intermittency, whereas in esotropia it is the relatively rare case that shows intermittency.

The high incidence of amblyopia in esotropia is a well-known clinical fact. In esotropia, alternating and uniocular cases are generally considered different degrees of an essentially similar condition, and, when amblyopia is present, it is secondary and develops as one form of the adaptation of the sensory apparatus to the strabismus. In exotropia, on the other hand, constant alternating and constant uniocular cases may not be considered as different manifestations of the same process.

Alternating exotropia in all respects resembles cases of intermittent exotropia, with the exception that the amount of fusion is inadequate to hold the eye straight for even part of the time. In this group, amblyopia (vision less than 20/40) is extremely rare. In uniocular exotropia, however, amblyopia is the rule; and, since a clear-cut obstacle to simultaneous macular perception may be demonstrated in most of the cases, it is

reasonable to assume that the strabismus is secondary to the amblyopia.

The role of the refractive error in the etiology and treatment also differs in esotropia and exotropia. It has been repeatedly and validly emphasized that there is an increased incidence of hyperopia in patients with convergent strabismus over that of the general population, roughly 80 percent.[14]

Correction of hyperopia in patients having esotropia has long been recognized as one of the most important single steps in the correction of esotropia. Adler[15] claims that 27 percent of esotropia is completely accommodative and 29 percent partially accommodative; in other words, hypermetropia plays an etiologic role in 56 percent of cases of esotropia.

Myopia does not play a similar role in exotropia. The incidence of myopia in patients with exotropia is the same as that of the general population. Furthermore, the correction of the myopic error in a divergent squint cannot be expected to diminish exotropia to the same degree or as frequently as the correction of hyperopia does in esotropia.

From the point of view of heredity, it has been shown that the direction of strabismus is inherited. In 150 cases[16] in which there was a familial incidence of strabismus, all but five of the families followed the rule that the direction of strabismus in a family is either convergent or divergent. Thus it would seem that there is a fundamental difference from the point of view of an inherited factor between convergent strabismus and divergent strabismus.

On the basis of the evidence outlined above, namely—the incidence of esotropia and exotropia in the general population, percentage of incidence of the different types of esotropia and exotropia, etiologic difference of the types, relation of the strabismus to amblyopia, the role of the refractive error, and the role of heredity—we would like to re-emphasize that esotropia and exotropia differ in many respects other than simple difference in the direction of the visual axes.*

## Summary

1. A total of 324 cases of exotropia were studied.

2. Exotropia occurs approximately one third as often as does esotropia.

3. The following classification for exotropia is recommended:

Intermittent exotropia
Constant alternating exotropia
Constant uniocular exotropia

4. Intermittent exotropia constitutes 85 percent of all cases of exotropia; the term refers to those cases which at times show manifest divergent strabismus and at times heterophoria, on the basis of temporal and spatial measurement of the squint.

5. Exophoria-exotropia is that condition in which, for any given distance of the object of fixation, the patient will at times show an exotropia and at times an exophoria of approximately similar degree.

6. The characteristics of the various subgroups of intermittent exotropia were studied from the points of view of measurements for distance and near and of near-point of convergence.

7. The incidence of myopia, emmetropia and hyperopia parallels that of the general population.

8. Only five percent of cases with intermittent exotropia are benefited by the correction of myopia, and here the effect is mainly on the measurement for near.

9. In intermittent exotropia it appears that fusion in the primary position is more apt to be "all or none" for distance fixation than for near: if present, it is more likely to be constantly present, or, if absent, to be totally absent. At the near measurement, fusion in the primary position is usually

* We thank Miss Dorothy Parkhill and Miss Leta Counihan (formerly of the Orthoptic Department of the New York Eye and Ear Infirmary) for their helpfulness in the compilation of the material used in this study.

present or intermittent, and very rarely absent.

10. In 16 percent of cases the deviation was greater for distance than for near; in 31 percent approximately equal for distance and near; and in 53 percent greater for near than for distance.

11. Although some cases fall into the classification of divergence excess and convergence insufficiency, the vast majority do not, and it is urged that the use of such categories be deemphasized.

12. Constant alternating exotropia constitutes approximately six percent of exotropia; such cases are similar to those of intermittent exotropia except that fusion is weaker. Hence, the patient does not exhibit exophoria even part of the time.

13. Constant uniocular exotropia constitutes about nine percent of exotropia. It differs from the other two types in that the strabismus is probably secondary to amblyopia, since a well-defined obstacle to clear vision in one eye can be demonstrated in most cases.

14. It has been shown that exotropia and esotropia differ fundamentally from the points of view of:

a. Incidence in the general population
b. Percentage of incidence of the different types of esotropia and exotropia
c. Etiologic differences of the types
d. Relation of the strabismus to amblyopia
e. The role of the refractive error
f. The role of heredity.

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# CONGENITAL DEFECTS IN THE RAT EMBRYO*

## AFTER PARTIAL THYROIDECTOMY OF THE MOTHER ANIMAL: A PRELIMINARY REPORT ON THE EYE DEFECTS

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### INTRODUCTION

The well-known Swiss goiter investigator Eggenberger[1,2] reports that in the goiter center, Appenzell, a relatively high percentage of congenital defects was found. In these areas he observed many cases of congenital deaf-mutism, disturbances in eye development, such as glaucoma and cataract, as well as harelip, cleft palate, anencephaly, spina bifida, and hypospadias. Eggenberger[3] gives as his opinion that these congenital defects may be of thyrogenous origin. However, he does not want to leave the hereditary factors, which undoubtedly play a part in these isolated spots, out of consideration. If, according to the author, it should be found that temporary hypothyreosis might have a teratogenic effect on the fetal human development, goiter therapy and goiter prophylaxis would acquire very great importance for offspring. Each diagnosed pregnancy struma might be accompanied by temporary hypothyreosis and would have to be treated with a view to the developing fetus.

Polman[4] and Pasma[5] called attention to the fact that in the southeast corner of Friesland, where goiter is endemic, the number of congenital defects is relatively higher than elsewhere. Also in this area spina bifida, deaf-mutism, and congenital eye defects are observed to a higher degree. In this connection Pasma[6] reports: "A struma apparently accompanied by a normal function, will during pregnancy not invariably have to be considered as a euthyroid goitre; it will then often have become hypothyroid. This hypothyreosis during pregnancy may cause deformation of the child."

Bloss[7] also observed some cases of hypothyreosis in the mother, which in his opinion resulted in disturbances in the children. Among these defects was a case of congenital bilateral cataract.

Furthermore, the literature includes a number of case reports, in which hypothyreosis of the mother is claimed to be the cause of congenital defects in the child (de Groot[8]; Elphinstone[9]; Hodge, Hamilton, and Keetel[10]).

Until recently the congenital defects were mainly approached from the genetic side. The importance of the exogenic conditions was more or less neglected.

Gregg[11,12] and Swann,[13,14] however, attracted attention to the fact that during the first few months of pregnancy the rubeola virus may cause congenital defects in the growing fetus. This shows that disturbances in development are not always caused by changes in the gene pattern. Congenital defects have often been determined genetically, but may also be caused by numerous exogenic factors.

Apart from food deficiency (Warkany and co-workers,[15–17] Giroud and co-workers[18,19]), irradiations, and other physical and chemical factors as exogenic causes of disturbances in development, experiments have been described of late in which a change in the hormonal conditions during pregnancy of the mother animal also causes congenital defects in the offspring.

Fainstat, Fraser, and Kalter[20–22] injected pregnant mice with cortisone; these injections caused cleft palates and other defects in the young mice.

Landauer[23,24] injected a solution of in-

* From the Anatomical-Embryological Institute, Free University. This work was made possible by support from the National Health Research Council, T.N.O.

sulin into hen's eggs. This caused a great number of rumpless embryos and chickens.

Lichtenstein, Guest, and Warkany[25] carried out similar tests on mammals. They administered protamine zinc-insulin to pregnant albino rats throughout the period of pregnancy. In addition to a high percentage of fetal deaths and resorption, skeletal defects were diagnosed in many instances. Also Duraiswami[26,27] could clearly demonstrate the important influence of insulin on the skeleton of the developing fetus. Besides, he obtained many cases of spina bifida.

Only few data are available about the formation of congenital defects in the mammal embryo owing to a dysfunction of the thyroid of the mother animal. Céni[28] reports that after thyroidectomy of chickens disturbances in the development of the embryos were observed. Especially the central nervous system was affected (anencephaly). Couland and Rouchon-Duvigneaud[29] describe a case of cataract in young rabbits, in which the mother had been irradiated during pregnancy in the thyroid region. Adams and Bull[30] studied the effect of antithyroid substances on chicken embryos. In addition to retarded hatching, reduced body weight, and changes in the thyroid, these investigators diagnosed strongly retarded ossification of the legs. Eye defects are not mentioned by the authors.

Weiss and Noback,[31] who studied the effect of thyroxin and thiouracil on the ossification in the rat, did not describe eye defects.

Giroud[32,33] daily administered a small dose of thyroxin to rats during pregnancy and often some days preceding pregnancy. In these embryos a large number of lens cataracts was diagnosed.

The clinical observations[1-10] already mentioned are in our opinion insufficient proof that a hypothyreosis can be held responsible for the congenital defects. In view of the results of modern investigations into the exogenic factors, we considered it desirable to conduct an experimental investigation into the influence of hypothyreosis during pregnancy of the mother animal on the morphogenesis of the embryos.

## Materials and Methods

For our experiments we used the albino rat (Wistar). This race was free from any congenital defects. The age of the animals varied from seven to 11 months. Warkany and Schraffenberger,[34] as well as Giroud,[18,19] emphasized the important part which food and particularly vitamins play in causing congenital defects. For this reason we paid special attention to the diet of the test animals, lest any defects diagnosed be attributable to food deficiencies.

The test animals were divided into four groups: the first 15 rats being used as check animals. In the second group of 15 test animals ($KE_{16}$-$KE_{30}$) the thyroid was partially removed before pregnancy. The period between operation and beginning of pregnancy was seven to 38 days.

The third group ($KE_{31}$-$KE_{44}$) was operated upon two to five days after the beginning of pregnancy. Also in these animals the thyroid was partially removed. The last group ($KE_{45}$-$KE_{52}$; $PE_{53}$-$PE_{58}$) was treated in the same way as the second group.

The beginning of pregnancy was determined with the vaginal smearing method according to Long and Evans. The thyroid was dissected under a dissection microscope (Zeiss-Opton) and partially removed. In this way the parathyroids could be spared in most cases, for Rollat[35] emphasized that hypocalcemia in human beings and animals may lead to cataract. Also other authors (Wibaut[36]) reported this observation. When a histologic check of the removed tissue showed that the parathyroids had been removed, the animal was at once eliminated from the test.

During the experiment none of the test animals showed eye defects which might be due to hypocalcemia.

To gain an impression about the effect of the partial thyroidectomy, the basal metabo-

lism was determined before and after the operation. For this purpose use was made of the principle of indirect calorimetry (closed method of Benedict[37]). The room in which the animals were examined was kept at a constant temperature.[38] Also the period of fasting preceding the metabolism[39] and the time of the day on which the basal metabolism rate was determined were taken into consideration.[40]

All the check animals and the operated rats were killed on the 20th day of pregnancy. Subsequently the uterus was extirpated, the embryos were dissected, and the eyes of the embryos fixed in Bouin fluid. According to Germani[41] postmortem eye effects occur within some hours. For this reason the eyes were invariably fixed as rapidly as possible.

In addition to eye defects, which will be extensively described in the following part, other defects were also observed. The number of embryos per pregnancy was smaller than in the check animals and the average weight was lower. A number of embryos showed cleft palates and harelip. Many embryos had subcutaneous hemorrhages, most of which were localized behind the ear and at the lower jaw. Ossification was in general retarded and in some cases abnormal.

An examination was made of the auditory organ. All these results will be extensively described elsewhere.

## Results

### Data on the embryos of the check animals ($KC_1$-$KC_{10}$; $PC_{11}$-$PC_{15}$)

The capsula vascularis and the capsula fibrosa lentis show a normal picture. The anterior lens epithelium cells lie close together. Toward the equator the cells acquire the columnar type. The nuclei of the lens fibers in the equatorial plane are regularly arranged and show various nucleoli (fig. 1).

Also the lens fibers have a regular normal pattern.

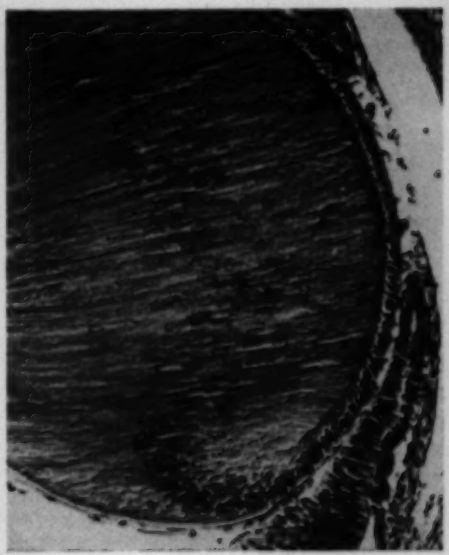

Fig. 1 (Langman and van Faassen). Magnification of lens shown in Figure 2.

Fig. 2 (Langman and van Faassen). Rat $KC_6$, embryo 2, right eye. General view of the normal eye of a 20-day-old embryo. Retina slightly detached.

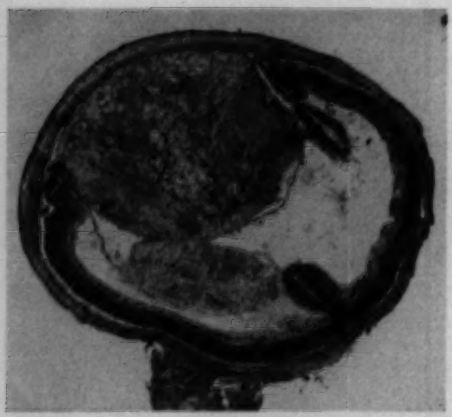

Fig. 3 (Langman and van Faassen). Rat $KE_{46}$, embryo 6, left eye. Thyroidectomy, April 1, 1953. Beginning of pregnancy, May 7, 1953. Uterus extirpation, May 27, 1953. General view: Central and peripheral internal retinal folds. Lens swollen, pronounced vacuole formation. Connection anterior lens epithelium cells broken. Iris and corpus ciliare pressed sideways. Anterior chamber disappeared.

In most of the check eyes the retina is torn from the choroid. Sometimes this contact is broken along the whole connecting plane and sometimes in some spots only. This is probably a result of fixation and cutting technique. (In the publications of Warkany, Giroud, Gillman, and Werthemann the same picture of normal eyes is encountered.) In a number of cases, where the retina is torn off for a great length, small internal retinal folds are sometimes perceptible. The histologic structure of the retina is invariably normal. The various layers are distinctly visible (fig. 2). In none of the check eyes are excessive fold formation, rosette formation, and inversion or eversion round the optic nerve found. Cornea, anterior eye chamber, iris, corpus ciliare, and corpus vitreum do not show defects. In some eyes remnants of the iridopupillary membrane and of the hyaloid artery are present.

### Data on the embryos of the test animals ($KE_{16}$-$KE_{30}$; $KE_{48}$-$KE_{52}$; $PE_{52}$-$PE_{58}$)

In these animals partial thyroidectomy had been carried out seven to 38 days before pregnancy. A large number of eyes (217) were examined microscopically for the presence of defects; 52 percent showed deviations from the normal picture, 29 percent of which had marked malformations. By reference to the preparation of eyes in different stages of degeneration we have tried to give a dynamic picture of the process.

*Lens*

The first stage of the degenerative changes is characterized by a swelling of the lens fibers at the posterior pole and in the center of the lens. This swelling process then extends to the anterior pole. Simultaneously small vacuoles are formed in the swollen lenses. The contents of these vacuoles may have different aspects. Sometimes they are granular and acidophilic and in other cases the granules are more basophilic. On progressing degeneration the boundaries of the lens fibers fade and the vacuoles merge (figs. 3 and 4). Owing to pronounced swelling and vacuole formation, the lens volume as a whole increases. This swelling may become so strong that iris and corpus ciliare are completely pushed aside. The lens then penetrates into the anterior eye chamber and often preparations are found in which the anterior pole of the lens is situated against the cornea.

The anterior epithelium cells, which under normal conditions lie close together, often lose contact and become detached. These cells are then drawn to the equatorial plane. The swollen and vacuolized fibers then penetrate through the plane of fracture of the epithelium cells to the capsula fibrosa (fig. 3).

On progressing degeneration of the lens fibers one sees a coarse-grained mass, with remnants of pyknotic nuclei and lumps of lens fiber. In some cases the epithelium cells in the equatorial region are therefore completely removed from the capsule and form an irregular pattern in the lens (fig. 5). In other cases the same picture is observed, but then the capsule has collapsed owing to the strong swelling of the lens. The detritus then flows into the space of the corpus vitreum or

into the anterior eye chamber (fig. 6). In the most serious cases almost the whole lens is destroyed and the center appears to consist of very strongly colorable granulation. Sometimes the structure is no longer recognizable at all. Also the capsula fibrosa is often torn and the corpus vitreum is locally completely destroyed by the penetrating cell material (fig. 7).

In addition to these degenerative changes our attention was attracted by a number of lenses with a very remarkable appearance (figs. 8, 9, and 10).

The anterior epithelium cells, which normally lie close together, show in some lenses interruptions, the rows of cells on both sides of the discontinuity bending inward. The epithelium cells become increasingly columnar in both directions and then form lens fibers. This picture is found in various spots within one lens and one gets the impression that

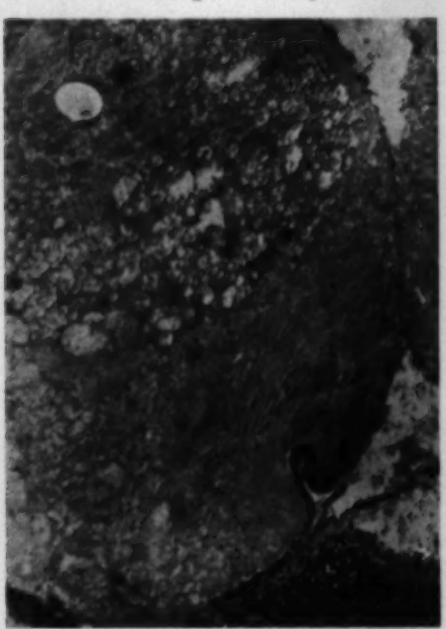

Fig. 4 (Langman and van Faassen). Magnification of lens shown in Figure 3. At equator, there are folding anterior lens epithelial cells. Distinct vacuole and granule formation. Fibers at equator are intact.

Fig. 5 (Langman and van Faassen). Rat KE$_{28}$, embryo 4, left eye. Thyroidectomy, April 1, 1953. Beginning of pregnancy, May 5, 1953. Uterus extirpation, May 27, 1953. General view: Central and peripheral retinal folds. Lens swollen. Epithelial cells removed from capsule by granular mass.

within the capsula fibrosa two or more separate small lenses have been formed, with a capsule of their own, regular arrangement of the anterior epithelium cells, formation of an equatorial region, and normal lens fibers. In some prepartions a distinct fissure and a small capsula fibrosa were visible between the various lenses (figs. 9 and 10). The posterior poles of these lenses merge and here the well-known degenerative changes are found. Finally, it should be stated that in some cases the lens is completely absent (fig. 11).

*Retina*

In nearly all cases where degenerative changes in the lens are diagnosed, the retina is not normal either. One of the most note-

Fig. 6 (Langman and van Faassen). Rat KE$_{28}$, embryo 4, right eye. For data see Figure 5. General view: Pronounced retinal folding. Posterior lens capsule ruptured. Lens contents migrated into the corpus vitreum. Distinct cataractous symptoms. Iridopupillary membrane present.

worthy defects is the occurrence of very pronounced fold formation (figs. 3, 5, 6, 7, and 8). This fold formation concerns the peripheral region as well as the central part of the retina. Fold formation is often so strong that hardly any space is left for the corpus vitreum.

In some eyes the optic nerve, upon entering the eyeball, is for a short distance surrounded by retina tissue (inversion).

When fold formation is slight, the histologic picture of the retina is normal. In the case of very strong fold formation it seems to us that, as far as can be judged from the preparations colored with hematoxylin-eosin, the various layers no longer possess their original structure. The cells of the retina have a rounder shape than normally.

Further histologic investigations are being carried out with various coloring methods to gain a better insight into the degenerative processes.

*Corpus vitreum*

The shape of the corpus vitreum is in most cases irregular. The fine fibrous structure has disappeared, partly owing to the penetration of the peripheral and central retina folds, and partly as a result of the marked swelling of the lens. In cases where the lens capsule is torn and the degenerative debris has penetrated into the corpus vitreum, the fiber structure is completely destroyed. In some eyes the corpus vitreum is reduced to a very thin layer, so that in various spots the vascular layer of the retina comes into contact with the posterior pole of the lens. Also, in many cases the hyaloid artery is visible.

Fig. 7 (Langman and van Faassen). Rat KE$_{48}$, embryo 1, left eye. Thyroidectomy, April 1, 1953. Beginning of pregnancy, May 7, 1953. Uterus extirpation, May 27, 1953. General view: Pronounced fold formation of retina. Lens shows degenerative symptoms. Rupture of lens capsule with migration of debris into the corpus vitreum.

*Iris, corpus ciliare, anterior eye chamber, cornea*

Owing to the swelling of the lens the iris and the corpus ciliare are to a considerable extent pressed sideways. No histologic defects are observed in the structure.

The anterior chamber has in many cases completely disappeared, sometimes owing to strong swelling of the lens, sometimes through a fracture in the frontal plane of the capsula fibrosa, as a result of which the degenerated lens fiber material has penetrated the anterior chamber. Also a clearly visible membrana iridopupillaris is often present. In eyes in which a complete coloboma has developed the cornea is often folded and highly thickened (fig. 11).

DATA ON THE EMBRYOS OF THE TEST ANIMALS ($KE_{31}$-$KE_{44}$)

In these animals partial thyroidectomy had been carried out two to five days after the beginning of pregnancy. These animals too were killed on the 20th day of pregnancy. To our surprise we could not find any defects in the lenses of the embryos. Not a single degenerative symptom was visible.

Fig. 8 (Langman and van Faassen). Rat $KE_{42}$, embryo 3, right eye. For data see Figure 7. General view: Retina heavily folded. Lens capsule ruptured in one spot. The anterior epithelial cells bend inward in some spots, becoming columnar and forming lens fibers. Lens epithelial cells and lens fibers also visible in the corpus vitreum. The lens center forms a vacuolized and granular mass.

Fig. 9 (Langman and van Faassen). Magnification of lens shown in Figure 8.

Only in some cases was the retina moderately or rather strongly folded. Coloboma was not observed. Corpus vitreum did not show any defects, except in those cases where retina folds were present. Iris, corpus ciliare, anterior eye chamber, and cornea were in all eyes quite normal.

## DISCUSSION

The supposition that these eye defects are of a hereditary nature is in all likelihood completely precluded. The check animals used did not show any defects. Also at the breeding farm which had supplied the animals, not a single eye defect had been found.

As has been known for years, the eye and particularly the lens are very sensitive to all kinds of exogenic factors, which may easily cause degenerative defects. This has been proved not only by many experimental investigations, but also by clinical data of Gregg[11,12] and Swann.[13,14]

Fig. 10 (Langman and van Faassen). Magnification of lens shown in Figure 8.

Töndury,[42-44] who has written some excellent publications about the occurrence of rubeola and lens turbidities, emphasized this fact. According to the author the rubeola virus penetrates the lens vesicle and then becomes enclosed by the epithelium cells. By mitosis of the cells which develop into lens fibers in the equatorial region the virus would be carried to the lens fibers. These are particularly sensitive owing to their high nucleoprotein metabolism and are destroyed by the virus. Not only the rubeola virus is claimed to have this capacity, but also the poliomyelitis virus.[45]

Ida Mann[46] is of the opinion that not the virus itself, but the disturbances in the metabolism caused by the virus cause the defects. Also Hurst[47] attributes the rubeola cataract to injury owing to insufficient nutrition of the lens fibers. To the best of our knowledge, animal experiments have not revealed eye defects which might be the result of virus diseases. On the other hand, many authors have described lens cataracts which are actually caused by exogenic factors.

Kaven[48] treated mice on the 18th to 19th day of pregnancy with X rays. In some cases the embryos showed lens cataract. When irradiation was carried out before the 17th day, other defects developed, such as cerebral lesions and hydrocephalus. The result of the irradiation was found to be dependent on the moment of pregnancy.

Von Hippel[49] conducted similar experiments. He irradiated pregnant rabbits on the sixth to 11th day for 15 minutes. In a number of young he found a typical central or zonular cataract. It does not seem probable to us that the eye defects which we observed in our experiments have anything to do with these causes.

Pagenstecker and von Szily[50] demonstrated as early as 1912 that the toxic action of various chemical reagents might cause congenital cataract and other eye defects in the embryo. They administered naphthalene to gravid rabbits and found a high percentage of congenital eye turbidities among the offspring.

Kusagawa[51] published an article on con-

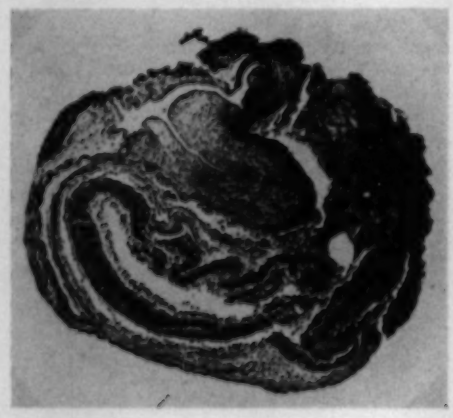

Fig. 11 (Langman and van Faassen). Rat KE$_{53}$, embryo 5, right eye. Thyroidectomy, April 1, 1953. Beginning of pregnancy, May 5, 1953. Uterus extirpation, May 26, 1953. General view: Retina shape very irregular, bending outward at bottom (coloboma). Sclera present only at top and back of eye. Cornea markedly thickened and folded. Lens absent.

genital lens turbidities in chickens. He fed naphthalene to the animals for some time. The embryos of the eggs of these chickens showed lens turbidities to the third and fourth generations. Also by direct injection of naphthalene into the egg the author could cause cataract in the embryos. Referring to the publications of Yoshida[52] and Hayano[53] the author suggests that the naphthalene acts on the endocrine organs either by its own toxic action or via the constitutional condition created by this substance. Owing to the disturbance in the endocrine organs, hereditary cataracts would then occur. These would be caused particularly by a reduced Ca-threshold in the blood. Kusagawa, however, does not want to preclude the direct toxic action of the naphthalene. Gillman and Gilbert[54,55] caused lens cataract in rat embryos by injecting the mother animals during gravidity with trypan blue. According to Gillman the trypan blue is adsorbed to an albumin fraction of the plasm protein, while it also acts on the reticulo-endothelial system, which will no doubt have its effects on metabolism.

Following experiments by Mitchell and Cook,[56] who succeeded in creating lens turbidities in mature rats by means of a diet rich in galactose, Bannon and co-workers[57] studied the influence of a diet rich in galactose on the lens of the developing rat embryo. A series of investigations actually showed that after administering a diet rich in galactose to the mother animals a high percentage of embryo cataract occurred. According to the authors this is due to a disturbance in the metabolism which would most of all affect the lens regions to a marked degree.

Other investigators (Day, Langston, and Brien,[58] Yudkin,[59] Bourne and Pyke[60]) demonstrated that feed deficient in vitamin $B_2$ may cause lens cataract in mature rats.

Warkany and co-workers,[61] as well as Giroud and Boisselot,[62] however, could not diagnose cataract in the embryos after administering a vitamin $B_2$-deficient feed to the mother animals.

It is difficult to say to what extent the above-mentioned causes might result in lens turbidity via the thyroid or other endocrinous factors. Anyhow, it does not seem likely to us. The experiments of Werthemann and Reiniger[63] are of great importance in our opinion. In an article on eye defects in rat embryos owing to $O_2$ deficiency during the first days of pregnancy, the authors publish photographs, some of which show a striking resemblance to our preparations. According to Werthemann these defects are of a very complex nature and are not attributable to a local oxygen deficiency.

Naujoks[64] also found eye and lens defects in chicken embryos when during the first five days of incubation the eggs were kept for a short time in a place deficient in $O_2$.

Ingalls, Tedeschi, and Helfern[65] found similar defects in mice. They paid special attention to the problem of retrolental fibroplasia.

The experiments of Bellows and Shoch[66] are more in the field of endocrinology. They studied the influence of alloxan diabetes on the lens. Also these investigators found typical cataractous changes which in their opinion are associated with the glutathione metabolism.

In none of the cases of lens turbidity caused by exogenic factors already described could we find direct points of contact for the lens defects obtained by us. In connection with the communication by Kusagawa[51] that naphthalene might cause lens turbidities via a hypocalcemia we have taken special precautions during the thyroid extirpation, as already described, to spare the parathyroids.

In addition, an investigation was conducted in which a given dose of methyl thiouracil was administered in drinking water and fed to rats some weeks before pregnancy. In this way injury to the parathyroids could be prevented, while hypothyreosis could be achieved. The results of this experiment, which has not yet been completed, also show eye defects which are of exactly the same nature as those obtained after thyroid extirpation before pregnancy of the mother

animal. Methyl thiouracil administered from the second to fifth day of pregnancy did not cause eye defects in the embryos.

An objection to these statements might be that the lens defects are caused by direct toxic action of the methyl thiouracil on the embryo. We have not yet been able to find references to this aspect in the literature. An experimental investigation carried out by one of us was not successful either. The lens defects found by us are in all likelihood the result of hypothyreosis of the mother animal during pregnancy.

A noteworthy phenomenon was that those eyes where lens turbidities were observed almost invariably contained retinal folds. As early as 1922 Zuckermann-Zischa[67] pointed to the occurrence of these eye defects. According to von Seefelder,[68] however, at least 50 percent of these cases should be considered as artificial and postmortem. It is not plausible that the retinal folds as found by us could be postmortem, because the eyes of the embryos were fixed immediately after uterus extirpation. Similar retina folding has been described by Gillman,[54, 55] Werthemann,[63] Mann,[46] and other authors. In these cases the histologic structure of the retina is not quite normal and rosette formations are observed in some spots.

It does not seem correct to us to consider the extreme folding only as artificial, the more so as retinal defects of a serious nature were invariably found in combination with lens defects.

We have asked ourselves whether it would be possible to account for the defects found. In this connection our attention was attracted by the publication of Werthemann,[63] who obtained similar retina and lens changes by transferring the test animals at the beginning of pregnancy to $O_2$-deficient surroundings. The link between these experiments may be the influence of the thyroid on the oxygenation processes.

The thyroid hormone is known to play an important part in the growth, maturation, and differentiation of the organism. Owing to its influence on the protein metabolism the thyroid will undoubtedly also affect the development of the lens, which is very sensitive to disturbances in metabolism, particularly during its formation. On the other hand, the question arises whether, as a result of the reduced basal metabolism rate in hypothyreosis, the $O_2$ supply to the tissues has also been reduced. Scheinberg and co-workers[69] investigated the arterial $O_2$ saturation of a number of patients suffering from myxedema. In addition to insufficient flow through the brain and slight anemia they also diagnosed insufficient $O_2$ saturation of the blood. Whereas in normal persons this saturation was about 97 percent, it varied between 70 percent and 97 percent in a number of hypothyreosis patients.

This undersaturation of the arterial blood might be caused by inadequate lung ventilation.

According to Hugget[70] the quantity of $O_2$ consumed by the growing embryo is considerably higher than is necessary for normal metabolism. Besides, he could demonstrate that, even under normal conditions, particularly the head of the embryo is provided with blood having a lower $O_2$ content. If, owing to some cause or other, a general $O_2$ deficiency should occur, the region of the head would be the most seriously affected part.

Hypothyreosis of the mother animal during gravidity might, via insufficient $O_2$ supply to the embryonal tissues, be an additional cause of the defects. Undoubtedly, the congenital defects can be ascribed to a complex of factors, among which may be $O_2$ deficiency, while the direct influence of the thyroid on the protein metabolism and other processes of metabolism may play an important part.

A noteworthy fact is that the eye defects were found particularly among those embryos whose mothers had undergone partial thyroid extirpation before pregnancy. The eyes of the embryos, the mothers of which had been operated upon two to five days

after the beginning of pregnancy, did not show lens defects. This may be ascribed to the fact that the degree of hypothyreosis in the former group was very high, particularly at the beginning of pregnancy. In the other group a very moderately reduced to normal basal metabolism could be diagnosed only at the beginning and middle period of pregnancy.

The degree and nature of the defect will probably depend on the degree of hypothyreosis during certain periods of pregnancy. Our investigations are being continued to determine this relation.

## Summary

The investigation was aimed at determining the influence of hypothyreosis of the mother animal on the development of the rat embryo.

For this purpose the thyroid was partially removed in some animals seven to 43 days before the beginning of pregnancy. In another group partial thyroidectomy was carried out two to five days after the beginning of pregnancy.

Various congenital defects were diagnosed in the embryos of the test animals which had been operated upon before pregnancy. In addition to a high percentage of eye defects, we found reduced body weight, retarded ossification, cleft palate, harelip, and hemorrhages of jaws and hind legs.

In the lens, cataractous symptoms were diagnosed in all possible degrees. In many cases the lens capsule was torn and the debris had migrated into the corpus vitreum or the anterior chamber. Some lenses showed very remarkable structures. The impression was that within one lens various small lenses had been formed. In addition to lens defects, peripheral and central retinal folds of moderate and serious nature were diagnosed. Also some cases of coloboma and anophthalmia were observed. The eyes of the embryos the mother of which had been operated upon during pregnancy did not show any lens defects, with the exception of some small retinal folds.

The nature and degree of the defects are probably dependent on the degree of hypothyreosis during certain periods of pregnancy. The possibility was discussed that the defects might be partly due to $O_2$ deficiency.

*Prins Hendriklaan 27.*

## Acknowledgement

The authors wish to express their grateful thanks to Prof. Dr. W. P. C. Zeeman, Amsterdam, for his enthusiastic support and helpful discussion of this project.

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# CYCLODIATHERMY IN GLAUCOMA

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Most ophthalmologists advise surgery when medication fails to control the intraocular pressure, as shown by loss of visual field. Compared with the results of other types of eye surgery the results are poor. Many a surgeon has been all too pleased to be relieved of his responsibility by the patient's refusal to permit surgery. The routine procedures, such as iridencleisis, sclerectomy, and trephination, are certainly mutilating operations and can seriously impair the integrity of the eyeball. Until the cause of glaucoma is understood the best that can be said for our present-day treatment is that it is the lesser of two evils.

It is quite understandable, therefore, that ophthalmologists have attempted cyclodiathermy with enthusiasm because of its technical simplicity. Its endorsement by leading authorities enhances the belief that a panacea for unruly glaucoma has been discovered.

Vogt's original procedure has been modified chiefly by placing the penetrating electrode six to seven mm. from the surgical limbus instead of directly over the pars ciliaris. Another modification has been reported by Berens in which he used electrolysis rather than diathermy, believing that a chemical destructive process is less damaging than a thermal reaction.

After reviewing the various techniques, it appears that a simple procedure can be quite as destructive as a complicated one. The destruction of a part of an organ, except in the case of a malignant growth, should cause the eye surgeon to hesitate before employing such a procedure. This would seem to be all the more important since it appears, at the present time, that the fundamental difficulty in glaucoma is in the outflow rather than in the excessive production of aqueous.

## TECHNIQUE

The technique of perforating cyclodiathermy described by Castroviejo was used. Briefly, it consists of:

1. Topical and retrobulbar anesthesia; van Lint akinesia.
2. Lid speculum or traction sutures for exposure.
3. The conjunctiva is not incised.
4. A Kronfeld 1.5-mm. electrode needle with insulation applied directly through the conjunctiva, six mm. from the limbus.
5. The electrode is held in place for 10 seconds each application, using a Cameron unit adjusted to 1.5 reading (approximately 50 milliamperes).
6. A maximum of 16 punctures evenly spaced at any one time, in between the insertions of the recti muscles.
7. Paracentesis with injection of air into the anterior chamber, as suggested by Castroviejo, to lower the tension which becomes elevated in some eyes because of scleral shrinkage, was not done.

## CASE REPORTS

### CASE 1

Mr. M. D., white, aged 79 years, had a diagnosis of absolute glaucoma, O.D., and chronic simple, narrow-angle glaucoma, O.S. Except for rapidly diminishing vision in both eyes, the symptoms were negative. The patient was unaware of the seriousness of his condition. Vision in the right eye was lost a year and a half before his first visit.

*First admission* (February 16, 1953). Vision was: O.D., no light perception (questionable); O.S., hand motions at six inches. Tension was: O.D., 80 mm. Hg (Schiøtz); O.S., 70 mm. Hg.

The fundi showed deep atrophic cupping. Triple miotics were prescribed and on discharge (February 19, 1953), tension was 32 mm. Hg, O.U.

*Second admission* (February 25, 1953). Less than a week later, he was readmitted with tension of: O.D., 65 mm. Hg (Schiøtz); O.S., 55 mm. Hg.

*Cyclodiathermy.* The first cyclodiathermy on the right eye was done on March 3, 1953, and consisted of eight punctures, two in each quadrant. Tension

averaged 25 to 30 mm. Hg for two days, but on the third postoperative day increased to 50 mm. Hg.

A week later (March 10, 1953) the first cyclodiathermy was done on the left eye. Nine punctures were made in the superior hemisphere. Tension was about 20 mm. Hg for two days but rose to 50 mm. Hg on the fifth postoperative day and remained at about that level until the seventh postoperative day.

On March 17th a second cyclodiathermy was done on the left eye. Two punctures were made in each quadrant. Tension varied between 8.0 mm. Hg to 10 mm. Hg until his discharge a week later. Drops were not prescribed. On discharge, tension was: R.E., 65 mm. Hg; L.E., 10 mm. Hg. Vision was: O.D., nil; O.S., motions at six inches.

On April 27th, he was readmitted with tension of: O.D., 48 mm. Hg (Schiøtz); O.S., 35 mm. Hg. Vision was: O.D., nil; O.S., motions at four inches.

The second cyclodiathermy was performed on the right eye the next day. Four punctures were made in the inferior hemisphere. On the fifth postoperative day, tension was: O.D., 33 mm. Hg; O.S., 24 mm. Hg. On the seventh postoperative day: O.D., 70 mm. Hg; O.S., 54 mm. Hg. Triple miotics and pilocarpine (four percent) were started. The tension on the eighth day was 24 mm. Hg, O.U. The patient was discharged on May 6th.

Table 1 is a summary of the follow-up data.

### Case 2

Thomas Cox, a Negro, aged 72 years, had a diagnosis of absolute glaucoma, O.D.; chronic simple glaucoma, O.S. He had known chronic simple glaucoma for the past two years and had been on four-percent pilocarpine, on and off.

Vision was: O.D., light perception only for nine months. Tension averaged 35 to 56 mm. Hg (Schiøtz), O.U., despite pilocarpine and DFP.

*On admission*, November 6, 1953, vision was: O.D., nil; O.S., 20/40. Tension was: O.D., 41 mm. Hg; O.S., 36 mm. Hg. The fundi, O.U., showed deep cupping.

*Cyclodiathermy*. On November 14, 1953, cyclodiathermy was performed on the left eye. Six punctures were made in the upper hemisphere, three in each quadrant. Tension in the left eye remained between 30 and 35 mm. Hg from the first postoperative day to the time of discharge two weeks later, despite four-percent pilocarpine, four times daily, and 0.1-percent DFP at bedtime. He was discharged on November 30th with tension in the left eye of 35 mm. Hg. Table 2 shows the follow-up data.

TABLE 1

FOLLOW-UP DATA IN CASE 1

| Date | Tension (mm. Hg (Schiøtz)) O.D. | O.S. | Remarks |
|---|---|---|---|
| 5/27/53 | 34 | 34 | |
| 6/ 1/53 | 30 | 30 | |
| 6/ 9/53 | | | Pilocarpine (6%) & DFP (0.1%) started |
| 7/20/53 | 17 | 17 | |
| 9/14/53 | 28 | 16 | |
| 10/14/53 | 90 | 38 | Not using drops |
| 11/30/53 | 75 | 30 | Not using drops |
| 12/11/53 | 56 | 26 | Pilocarpine (6%) & DFP (0.1%) |

TABLE 2

FOLLOW-UP DATA IN CASE 2

| Date | Tension (mm. Hg (Schiøtz)) O.D. | O.S. | Remarks |
|---|---|---|---|
| 9/16/53 | | | Fields, O.S., 15 to 20-degree peripheral concentric contraction; 15-degree central concentric contraction; vision, O.D., nil |
| 12/ 4/53 | 48 | 35 | Pilocarpine (6%) six times daily |
| 12/11/53 | 45 | 35 | |

### Case 3

Rose McK., aged 81 years, white, had the diagnosis of chronic simple glaucoma, O.U. A filtering operation had been done on the right eye, 13 years before. She had been on pilocarpine, O.U., over a period of years. Tension in the left eye remained in the upper range limit.

*On admission*, on September 18, 1953, tension was: O.D., 22.3 mm. Hg (Schiøtz); O.S., 37.5 mm. Hg. Vision was: O.D., 20/100; O.S., 20/70 (with or without correction).

*Cyclodiathermy*. On September 19, 1953, cyclodiathermy was done on the left eye; 12 punctures, three in each quadrant, were made. She was discharged on September 30th with tension of: O.D., 27 mm. Hg; O.S., 38 mm. Hg. Pilocarpine (two percent) was prescribed.

*Follow-up*. On October 16, 1953, tension was: O.D., 19 mm. Hg; O.S., 25 mm. Hg. Vision was: O.D., 20/100; O.S., 20/40 (with or without correction). Four-percent pilocarpine was continued.

### Case 4

Carter C., a Negro boy, aged nine years, had the diagnosis of juvenile glaucoma, O.D., and surgical anophthalmos, O.S.

*History*. He was first seen at the Massachusetts Eye and Ear Infirmary on August 15, 1946, with tension of: O.D., 20 mm. Hg (Schiøtz); O.S., 63 mm. Hg. On August 16th, an iridencleisis had been performed on the left eye, with subsequent enucleation in January, 1947, for a "suspicious" glioma, not confirmed by histopathologic study. Tension in the right eye remained normal. Megalocornea (12.5 by 13 mm.) was present in the right eye.

He was next seen at the Boston City Hospital on July 20, 1950, because of a lost prosthesis, O.S. At

this time tension was: O.D., 30 to 35 mm. Hg, with pilocarpine. Fields were full and vision in the remaining right eye could be corrected to 20/30.

*First admission,* December 3, 1952. Tension, O.D., was 29 mm. Hg (Schiøtz); vision was (with correction) 20/30. The fields were full. There was a very slight enlargement of the blindspot. The fundus showed questionable slight cupping. Provocative tests were noninformative. The diurnal variation in tension was: a.m., 30 to 22 mm. Hg; p.m., 25 to 27 mm. Hg.

*Cyclodiathermy.* The first cyclodiathermy on the right eye was done on February 21, 1953, and consisted of eight punctures in the lower hemisphere. For two weeks postoperatively the tension averaged 10 to 11 mm. Hg. He was discharged on March 9th, with a tension in the right eye of 15 mm. Hg.

*Second admission.* On April 27th he was admitted for a second time with tension in the right eye of 42 mm. Hg (Schiøtz); vision, 20/30, with correction.

*Cyclodiathermy.* On May 16th, the second cyclodiathermy procedure was done on the right eye, eight punctures in the upper hemisphere. Until discharge, with no medication, the tension averaged 15 to 17 mm. Hg. Follow-up data are summarized in Table 3.

CASE 5

Mr. M. C., a white man, aged 70 years, had the diagnosis of glaucoma, vitreous pupillary block (Chandler), O.S.

*History.* On February 12, 1952, an intracapsular lens extraction was done on the left eye, with postoperative hyphema. Due to the appearance of the iris, a pupillary block was surmised.

On June 6, 1952, tension in the left eye was 52 mm. Hg (Schiøtz), and there was no response to intense medical therapy. On July 22, 1952, a transfixion of the iris, O.S., was done but the tension remained between 55 to 65 mm. Hg.

*Cyclodialysis.* After cyclodialysis on July 26th, tension in the left eye averaged 40 mm. Hg. On August 23rd, cyclodialysis on this eye was repeated and tension averaged 38 to 48 mm. Hg. On August 27 tension was 27 mm. Hg.

TABLE 3

FOLLOW-UP DATA IN CASE 4

| Date | Tension (mm. Hg (Schiøtz)) O.D. | Remarks |
|---|---|---|
| 6/22/53 | 30 | Pilocarpine 2% started |
| 7/ 6/53 | 30 | Pilocarpine 2% continued |
| 8/19/53 | 25 | Pilocarpine 2% continued |
| 9/11/53 | 30 | DFP 0.1%, 2 times wk. started |
| 10/27/53 | 15 | DFP continued |
| 11/ 4/53 | 25 | DFP continued |
| 12/11/53 | 26 | DFP continued |

TABLE 4

FOLLOW-UP DATA IN CASE 5

| Date | Tension (mm. Hg (Schiøtz)) O.S. | Remarks |
|---|---|---|
| 11/ 3/52 | 22 | |
| 12/ 8/52 | 25 | |
| 1/ 5/53 | 22 | |
| 3/ 2/53 | 25 | Central field, moderate concentric constriction |
| 4/17/53 | 34 | |
| 5/ 1/53 | 34 | |
| 6/24/53 | 28 | |
| 7/15/23 | 24 | |
| 11/ 2/53 | 23 | Vision, O.S., 5/200, with correction 18/200 |
| 12/ 9/53 | 23 | |

*Admission.* On October 22, 1953, tension was: O.D., 29 mm. Hg (Schiøtz); O.S., 62 mm. Hg. Vision was: O.D., 20/100; O.S., 2/200; with correction, O.D., 20/20; O.S., 6/200.

*Cyclodiathermy.* On October 23rd, cyclodiathermy was done on the left eye, eight punctures being made in the lower hemisphere. The patient was discharged the next day. Follow-up data are presented in Table 4.

CASE 6

Mr. John R., white, aged 70 years, had the diagnosis of chronic simple glaucoma, O.U., with an acute attack, O.D.

*History.* He was first seen three years ago, with failing vision, O.U., for the past several months. At that time tension, O.U., was 65 mm. Hg (Schiøtz); vision was: O.D., 20/200; O.S., 20/100. The fields were tubular (10 degrees). The patient was immediately placed on four-percent pilocarpine, four times daily, and a cyclodialysis was done on the right eye, December 14, 1950. He was discharged on December 21st, with tension of: O.D., 25 mm. Hg; O.S., 22 mm. Hg.

*First admission.* On April 27, 1953, tension in the right eye was 65 mm. Hg (Schiøtz); left eye, 43 mm. Hg. Vision was: O.D., hand motions; O.S., counting fingers at three feet.

*Cyclodiathermy.* On May 5, 1953, an eight-puncture (two in each quadrant) cyclodiathermy procedure was carried out on the right eye. Beads of vitreous were drawn at three points at the nasal punctures. There was marked fluid hyphema. The right eye was acutely congested after the procedure.

On May 19th, an iridencleisis was performed on the left eye. The patient was discharged on June 6th, on four-percent pilocarpine, six times daily, and "triple miotics." Tension was O.D., 60 mm. Hg; O.S., 32 mm. Hg. Gross hyphema was still present in the right eye. Table 5 summarizes the follow-up data.

TABLE 5

FOLLOW-UP DATA IN CASE 6

| Date | Tension (mm. Hg (Schiøtz)) O.D. | O.S. | Vision O.D. | O.S. | Remarks |
|---|---|---|---|---|---|
| 6/22/53 | 48 | 28 | HM, at 3 ft. | 5/200 | Pilocarpine 4% |
| 6/29/53 | 55 | 35 | LP | 5/200 | Pilocarpine 4% Fields, O.S., 10 degrees |
| 7/13/53 | 48 | 28 | | | Pilocarpine 4% |
| 8/ 3/53 | Soft | 29 | LP | 5/200 | Pilocarpine 4% ?Uveitis |
| 8/17/53 | Soft | 30 | LP | 5/200 | Pilocarpine 4% and cortisone |
| 9/14/53 | Soft | 22 | LP | 5/200 | Pilocarpine 4% and cortisone |
| 10/ 9/53 | 4 | 22 | LP | 5/200 | Pilocarpine 4% and cortisone |
| 11/13/53 | Soft | 22 | LP | 5/200 | Pilocarpine 4% and cortisone |
| 12/ 2/53 | Very soft | 23 | Nil | 5/200 | Pilocarpine 4% and cortisone |

CASE 7

Julia A., a 76-year-old Negress, had aphakic glaucoma, O.S. After an intracapsular lens extraction, O.D., on November 29, 1951, a postoperative cyclitis cleared in two months under cortisone and atropine. Tension, O.D., has always remained normal. A week after an intracapsular lens extraction, O.S., on March 20, 1952, the patient "rubbed her eye" and the wound ruptured. The course after repair was uneventful. At examination in April, ciliary tenderness was present.

*Cyclodiathermy.* On May 6, 1953, she was admitted to the hospital with tension of 48 mm. Hg (Schiøtz) in the left eye. Vision was: O.D., 20/30, with correction; O.S., 10/200.

The next day, eight cyclodiathermy punctures were made in the lower hemisphere, four in each quadrant. The following day, tension rose to 51 mm. Hg and then averaged between 30 and 32 mm. Hg for the next five days without medication. One-percent pilocarpine was started on the sixth postoperative day and for the next four days tension ranged between 25 and 29 mm. Hg. She was discharged on May 22nd, with tension, O.S., of 26 mm. Hg. The follow-up data appear in Table 6.

CASE 8

Alice H., a white girl, aged 15 months, had hydrophthalmos, O.U. She was born at full-term with a weight of five lb. Although she had had photophobia for 10 months, her mother never suspected an ocular condition.

*On admission,* December 3, 1953, the corneas measured 17 mm. in diameter and the vision was reaction to bright light. Tension was: O.D., 33 mm. Hg (Schiøtz); O.S., 75 mm. Hg.

Cyclodialysis with iridectomy and anterior sclerectomy was performed on both eyes on December 6, 1953. Tension under anesthesia before operation was: O.D., 40 mm. Hg; O.S., 77 mm. Hg. Cyclodiathermy was done on both eyes, five punctures in the lower hemisphere of each eye. No miotics were used.

On December 19th, digital tension, O.U., was soft, and it remained soft at follow-up examination on December 21st.

TABLE 6

FOLLOW-UP DATA IN CASE 7

| Date | Tension (mm. Hg (Schiøtz)) O.D. | O.S. | Remarks |
|---|---|---|---|
| 6/ 5/53 | 18 | 35 | DFP started. Fields, 15–20 degrees |
| 6/22/53 | 20 | 27 | DFP continued. Vision, O.S., 4/200, cc |
| 7/ 6/53 | 16 | 27 | DFP continued |
| 9/14/53 | 17 | 26 | DFP continued |
| 11/30/53 | 19 | 30 | DFP continued. Vision, O.S., cc 20/40 |

CASE 9

Jesse G., a 67-year-old white man, had aphakic glaucoma, O.S. He had had an intracapsular lens extraction on November 18, 1952, with vitreous loss. Three weeks later he was seen on the accident floor with tension, O.S., of 50 mm. Hg (Schiøtz). A paracentesis and DFP were without results.

*On admission,* January 28, 1953, tension was: O.D., 22 mm. Hg (Schiøtz); O.S., 35 mm. Hg. Vision was: O.D., 20/70; O.S., 4/200.

*Cyclodiathermy.* Nonperforating cyclodiathermy was performed on the left eye with a flat electrode through a conjunctival flap, in the lower hemisphere, three mm. back from the limbus. Tension remained around 30 mm. Hg.

On March 7, 1953, a second cyclodiathermy procedure was carried out on the left eye. Six punctures, three in each quadrant, were made in the upper hemisphere. At discharge on March 11th, tension in the left eye was 25 mm. Hg. The postoperative follow-up is shown in Table 7.

CASE 10

William J., a 52-year-old Negro, had the diagnosis of traumatic cataract with secondary glaucoma, O.S. He stated that he had been hit in the

TABLE 7

FOLLOW-UP DATA IN CASE 9

| Date | Tension (mm. Hg (Schiøtz)) O.D. | O.S. | Vision O.D. | O.S. | Remarks |
|---|---|---|---|---|---|
| 4/ 6/53 | 22 | 25 | 20/40 | 5/200 | No drops |
| 4/22/53 | 23 | 22 | | | |
| 5/27/53 | 23 | 17 | | | |
| 7/22/53 | 27 | 16 | | | |
| 9/ 2/53 | 22 | 22 | | | |
| 10/21/53 | 23 | 15 | 20/70 | 6/200 | No drops |

eye about 18 years ago but had forgotten the exact nature of the blow.

*Admission.* (March 16, 1953). Tension was: O.D., 19 mm. Hg (Schiøtz); O.S., 40 mm. Hg. Vision was: O.D., 20/50; O.S., hand motions. The fundus of the left eye showed an old chorioretinitis.

*Cyclodiathermy.* On March 17th, six cyclodiathermy punctures were made in the inferior hemisphere of the left eye, three in each quadrant. He was discharged on March 24th, with tension, O.U., of 23 mm. Hg. No drops were prescribed. The follow-up data are in Table 8.

CASE 11

Debra L., a white girl, was born on January 3, 1953. Her birth weight was six lb. Her mother had had German measles during gestation. The child was referred to the eye service for hazy corneas. The diagnosis was hydrophthalmos, O.U.

*Admission.* When admitted on January 8, 1953, the tension was: O.D., 40 mm. Hg (Schiøtz); O.S., 37 mm. Hg. Tension was taken under vinethene ether.

*Cyclodiathermy* was done on both eyes the same day. Three punctures were made in each quadrant. No miotics were prescribed.

TABLE 8

FOLLOW-UP DATA IN CASE 10

| Date | Tension (mm. Hg (Schiøtz)) O.D. | O.S. | Remarks |
|---|---|---|---|
| 3/30/53 | 34 | 34 | No drops |
| 4/12/53 | 26 | 18 | Vision: O.D., 20/30; O.S., fingers 6 ft. |
| 5/11/53 | 24 | 40 | 2% pilocarpine 4 times daily started |
| 5/25/53 | 26 | 29 | Pilocarpine continued; fields full, O.D. |
| 6/ 8/53 | 24 | 35 | Pilocarpine continued |
| 7/ 6/53 | 24 | 36 | Pilocarpine continued |
| 8/17/53 | 29 | 56 | 4% pilocarpine started |
| 8/24/53 | 28 | 35 | Pilocarpine continued |
| 9/ 4/53 | 18 | 20 | Pilocarpine continued |
| 10/16/53 | 22 | 22 | Pilocarpine continued |
| 11/30/53 | 19 | 30 | Pilocarpine continued; Vision: O.D., 20/30; O.S., fingers |

On January 22nd, under anesthesia, tension, O.U., was "very hard" with a 10-gm. weight. Goniotomy was done on the right eye on January 24th and on the left eye on January 27th. DFP (0.1 percent, once daily) was started.

On February 12th, under anesthesia, tension was: O.D., 26 mm. Hg; O.S., 46 mm. Hg.

*A second cyclodiathermy,* six punctures in the lower hemisphere, was done on the left eye on February 21st. On March 7th, tension was: O.D., 25 mm. Hg; O.S., 14 mm. Hg.

By May 13th there was phthisis bulbi, O.S. On June 10th, the tension, O.D., under anesthesia, was 11 mm. Hg. On November 5, 1953, tension, O.D., was 25 mm. Hg.

CASE 12

Eleanor E., a 52-year-old Negress, had glaucoma secondary to granulomatous uveitis (? sarcoid), O.D.

*Admission.* On April 24, 1953, she was admitted for study and given typhoid injections ranging from 10 to 75 million units per dose. Search for the etiology of the granulomatous uveitis narrowed down to either a latent tuberculosis or sarcoid. From a base of 56 mm. Hg (Schiøtz) tension, O.D., dropped to an average of 35 to 40 mm. Hg. Local and systemic cortisone plus salicylates and penicillin was given. Paracentesis had no effect on the tension.

On June 15, 1953, she was admitted with tension of: O.D., 50 mm. Hg; O.S., 22 mm. Hg. Vision was: O.D. counting fingers; O.S., 20/30.

*Cyclodiathermy.* On June 18th, 14 cyclodiathermy punctures were made on the right eye, three in each upper quadrant, four in each lower. Tension, O.D., averaged between 25 and 30 mm. Hg. Cortisone drops only were prescribed. The patient was discharged on June 24th with tension of: O.D., 30 mm. Hg. Vision, O.D., counting fingers at two feet. The follow-up data are in Table 9.

CASE 13

Beatrice S., a 55-year-old white woman, had the diagnosis of acute congestive narrow-angle glaucoma, O.S. This was the first attack. She had had severe pain and blurring in the left eye for the past five days without treatment.

*Admission.* She was admitted on September 28, 1953, with vision of: O.D., 20/70; O.S., counting

TABLE 9

FOLLOW-UP DATA IN CASE 12

| Date | Tension (mm. Hg (Schiøtz)) O.D. | O.S. | Remarks |
|---|---|---|---|
| 7/ 6/53 | 26 | 26 | No miotics |
| 7/27/53 | 25 | 25 | |
| 8/28/53 | 19 | 22 | Vision, O.U., 20/100, with correction |
| 9/25/53 | 25 | 25 | |
| 11/ 4/53 | 22 | 22 | Vision, O.U., 20/40, with correction. Fields, O.U., full central & peripheral |

fingers at four feet. Tension was: O.D., 35 mm. Hg (Schiøtz); O.S., 85 mm. Hg. She was immediately placed on triple miotics.

*Cyclodiathermy.* On September 29th, tension was: O.D., 22 mm. Hg; O.S., 16 mm. Hg. Cyclodiathermy was done on the left eye, eight punctures, four in each quadrant, being made in the lower hemisphere. This procedure was combined with a superior basal iridectomy. There was postoperative fluid hyphema for some time. When she was discharged on October 2nd, tactile tension, O.S., was soft.

*Follow-up.* On December 15th, a telephone report from her doctor said that, when she had been seen two weeks earlier, tension, O.S., was soft and vision was around 20/70.

### CASE 14

Simon M., a 40-year-old man, had the diagnosis of chronic simple glaucoma, wide-angle, O.D. He was first seen on January 27, 1953, with the chief complaint of a rainbow in front of his right eye four to five days previously. With correction, vision was: O.D., 20/30; O.S., 20/100. The right eye had always been the better eye.

Tension, O.D., ranged between 26 and 40 mm. Hg (Schiøtz). After dilatation with paredrine, some deep-seated lenticular opacities could be seen in the upper quadrant. The visual field showed a constriction on the temporal side, as well as on the temporal lower and upper quadrants. While the nasal side seemed normal.

The fundi were normal. A tonographic examination showed a wide-angle glaucoma.

*Admission.* When admitted on March 20, 1953, tension was: O.D., 45 mm. Hg. Vision, with correction, was: O.D., 20/30; O.S., 20/100.

*Cyclodiathermy.* On March 21st, four punctures, two in the upper temporal and two in the lower nasal quadrants, were made on the right eye. He was discharged on March 24th with tension, O.D., of 26 mm. Hg, on one-percent pilocarpine twice daily. Until May 8, 1953, tension was between 18 and 28 mm. Hg, but the tendency was to increase and stay at a higher level.

On June 5, 1953, he was readmitted with a tension in the right eye of 26 mm. Hg. A second cyclodiathermy was done on the right eye on June 6th, eight punctures, two in each quadrant. He was discharged June 9th, with tension, O.D., of 16 mm. Hg.

*Follow-up.* For the next two months, the tension stayed down. Then it began to show a tendency to rise but was controlled under pilocarpine, three times a day. When last seen on December 12, 1953, vision, visual fields, and fundus had remained the same over the months. The tension was being controlled at about the same level under pilocarpine.

## DISCUSSION

We admit that the number of cases is small and that the follow-up period in "successful" cases is not long. However, it is not necessary to lose "a hatful of eyes" to recognize the fact that cyclodiathermy is not a cure-all for glaucoma. Certainly it seems contraindicated in the acute, congested, narrow-angle type of glaucoma. It does have some therapeutic value in congenital buphthalmos. It may be considered in an aphakic glaucoma. When all other procedures have failed, it can be used as a last resort if it is fully realized that there is danger of sympathetic ophthalmia.

## SUMMARY

In this brief series of 17 operations on 14 eyes, cyclodiathermy as advocated by Castroviejo, was used. The results do not justify including this operation with such standard procedures, as iridencleisis, trephination, and sclerectomy.

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# STENOSIS OF THE LACRIMAL CANALS AND PUNCTA

## Caused by the Stevens-Johnson syndrome

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Stevens-Johnson syndrome, which was first reported in 1922,[1] is a form of erythema multiforme bullosa characterized by widespread lesions. These involve the mucous membranes as well as the skin. Marked constitutional symptoms with high fever are typical. The disease varies in severity and can be fatal as shown in the case reported by Bruinsslot and Schornagel[2] in 1948.

The skin eruption is symmetric and consists of bluish-red macules, papules, and bullae surrounded by a red halo. Associated are lesions of the lips, mouth, and conjunctiva.

The conjunctivitis is severe and destructive. Pain and photophobia result in blepharospasm. Follicles are pronounced and necrotic patches may occur. Membranes or pseudomembranes heal with fibrosis which can lead to obliteration of the fornices and puncta and, also, symblepharon. Corneal involvement consists of circumcorneal injection, loss of luster, and drying. Vesicle formation is followed by shrinkage as in the conjunctiva. Complete opacification and perforation of the globe have been known to occur. Milder cases may occur without corneal involvement.

Although the disease is usually a pediatric problem, Jones, Talbot, and King,[3] in 1946, reported a case in a woman, aged 56 years, which was severe but in which the nasal, buccal, and cutaneous lesions subsided. They review the literature up to that time and believe, as does Duke-Elder,[4] that of the three types of ocular erythema multiforme (catarrhal, purulent, and membranous), the name Stevens-Johnson disease should be reserved for the purulent; that is, purulent conjunctivitis, stomatitis, and a cutaneous rash without membrane formation.

Richards and Romaine[5] in 1946 reported a severe case in a 28-year-old woman in which the ocular involvement consisted of keratoconjunctivitis complicated by superficial and deep vascularization of the cornea, symblepharon, keratoconjunctivitis sicca, and recurrent ulcers of the cornea. Perforation of the cornea with incarceration of the iris necessitated enucleation of the right eye, while scarring of the left cornea reduced the vision to 20/200.

The etiology is unknown and no causative agent has ever been isolated. While Jones,[6] in 1950, isolated antibodies of the psittacosis group of viruses in two of three cases, he drew no conclusions on the matter other than more laboratory investigations are desired. Hansen[7] in 1950 presented eight cases and concluded that the etiology is probably an inherent or acquired sensitivity to drugs or other agents. He postulates, too, that the disease may be a variation of the same basic condition that causes ocular pemphigus, especially since they can resemble each other so closely.

As far as treatment is concerned, the best results have been reported with ACTH and cortisone. Salak and Ghanem,[8] in 1951, reported two cases cured by aureomycin. Pritchett and Austin,[9] in 1951, reported two cases that apparently responded to terramycin and aureomycin. Khayat and Jacoby,[10] in 1947, reported one case of dramatic cure with aureomycin. Chipps,[11] on the other hand, reviewed a case in which aureomycin was of no benefit. Mecklin and Saunders,[12] in 1952, reported a case which did not respond to penicillin or terramycin but did respond dramatically to systemic cortisone. Several other investigators have reported dramatic response to and cure by cortisone or ACTH therapy.[13–15] It is interesting to note one case reported in the literature which responded very well to cortisone after not having responded to ACTH.[13]

The following is a case report of a patient with complications of the Stevens-Johnson syndrome treated by us at the Manhattan Eye, Ear, and Throat Hospital.

## Case report

F. J., a 10-year-old Negro boy, was first seen on July 14, 1953, with a chief complaint of tearing of both eyes since November, 1952. Vision was 20/20 in each eye. External examination was negative except for adhesions between the upper and lower eyelids at the puncta in both eyes (fig. 1). In October, 1952, the patient had been at Willard-Parker Hospital and the following is a summary of his hospital stay there.

*Willard-Parker Hospital History.* F. J. was admitted on October 13, 1952, and discharged on November 26, 1952, with a final diagnosis of Stevens-Johnson syndrome and erythema multiforme bullosum. The patient had been referred as a possible diptheria case with a four-day history of upper respiratory infection, vomiting, diarrhea, stomatitis, exudative tonsillitis, and severe conjunctivitis with purulent discharge.

The morning of admission, he developed a generalized maculopapular vesicular rash. Temperature on admission was 103.8°F.

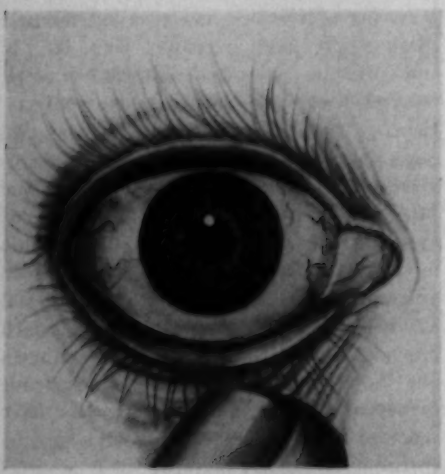

Fig. 1 (Mamelok and Laval). Diagrammatic illustration of cicatricial membrane in region of caruncle prior to surgery. Both eyes were similarly affected.

The conjunctiva of both eyes was injected and a purulent discharge was present. The conjunctival smear of the right eye had a few pus cells and no organisms while that of the left eye had many pus cells and no organisms. Culture of the right eye was sterile but hemolytic Staphylococcus aureus was grown from the left eye.

Treatment consisted of cortisone tablets, 50 mg. every eight hours for three doses starting on October 17, 1952, and then 25 mg. every eight hours through October 27, 1952. On October 28, it was cut to 25 mg. every 12 hours; on October 29, to 12.5 mg. every 12 hours; and on October 30, till the end of the hospital stay, to 6.25 mg., every 12 hours. In addition, he received sulfadiazine, 0.5 gm. every six hours from November 3 through November 6, 1952; thiamin chloride, 25 mg. daily from October 19 through November 26, 1952; and nicotinic acid, 25 mg., twice a day from October 19 through November 26, 1952.

Local treatment of the eyes consisted essentially of aureomycin ointment twice a day and cortisone drops (1.5 percent) every two hours for two weeks, saline compresses, and washes, and mineral oil.

The patient's temperature during the first week oscillated between 101°F. and 105°F. On October 22, 1952, the temperature dropped to 100°F. and ranged from 98° to 100°F. the next four weeks. The last four days of hospitalization, and, thereafter, the temperature remained 98.6°F.

The conjunctivitis remained purulent for four days and then started to improve. With the improvement, however, occurred thickening of the lids and conjunctiva. The general condition improved as well so that, at the time of discharge, the physical examination was negative except for continuous watering of the eyes and some scattered, dark, pigmented areas on the skin, a result of the eruption.

*Present hospitalization.* Since it was ap-

parent that the origin of the tearing was mechanical, surgical correction of the blockage was decided on. Therefore, on August 13, 1953, a polyethylene tube was inserted in the left lacrimal sac. This was done by first dissecting and removing the scar tissue between the upper and lower puncta. (Report on the specimen sent to the laboratory was "chronic, hypertrophic inflammatory tissue.") A passage was then started with a sharp blade at the site of the lower punctum. A probe was passed through this partial passage into the lacrimal sac. After the probe was removed, a stylet containing a polyethylene tube was inserted through the passage into the sac. The stylet was removed but the polyethylene tube was left in place. The exposed part of the tube was taped to the patient's cheek.

The following day, lipiodol was injected into the tube and X-ray films showed the opaque media had ready egress into the nasal cavity.

The tube stayed in place and on October 22, 1953, the same procedure was repeated on the right side. The report on the specimen sent to the laboratory did not differ from the one of the first operation.

One month later, the right tube was extruded and so was replaced on November 24, 1953. X-ray films on December 31, 1953, showed that both tubes were still in place as desired. On January 27, 1954, both tubes were still in place causing only mild irritation.

They were removed on March 15, 1954, when it was felt that they had served their purpose. The left tube had been in place seven months and the right one about five months.

On March 23, 1954, probing with a No. 2 probe on the right side was successful but unsuccessful on the left. When last seen on March 28, 1954, neither side could be irrigated through to the nose and the patient again had tearing of both eyes.

## Discussion

The purpose of reporting this case is to illustrate the therapeutic difficulties. The problem is very real because, even if cortisone and ACTH can prevent extensive scarring in the Stevens-Johnson syndrome, this is not true in every case. Furthermore, this case suggests that these agents may not always prevent scarring in other types of conjunctivitis that tend to terminate in cicatrization.

A second point we should like to bring out is that polyethylene tubing does not provide the answer in all cases of lacrimal obstruction.

## Summary

1. A case of Stevens-Johnson syndrome complicated by lacrimal obstruction, secondary to cicatrization of the conjunctiva occluding the puncta, was presented.

2. Surgical treatment of the case with polyethylene tubing was discussed.

3. The literature of Stevens-Johnson syndrome has been reviewed.

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# STUDY OF EXPERIMENTAL INTRAOCULAR INFECTION*

## I. The recoverability of organisms inoculated into ocular tissues and fluids

## II. The influence of antibiotics and cortisone, alone and combined, on intraocular growth of these organisms

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The present study was undertaken to determine the role of cortisone in the treatment of intraocular infections. It was divided into two main phases: the first was concerned with the ability to recover the organisms responsible for the intraocular infection from the intraocular fluids; the second was to determine the merit of cortisone and antibiotics as compared to cortisone and antibiotics alone in the therapy against standard intraocular infections.

* From the Research Department of Wills Eye Hospital. A thesis submitted by Dr. Maylath to the faculty of the Graduate School of Medicine of the University of Pennsylvania, toward the requirements for the degree of Master of Medical Science [M.Sc. (Med.)] for graduate work in ophthalmology. This investigation was supported by a research grant from the National Institute of Health, United States Public Health.

### I. Recoverability of organisms

#### Method

Eighteen-hour brain-heart infusion-broth cultures of coagulase positive Staphylococcus aureus, Bacillus pyocyaneus, and Escherichia coli were used. The cultures were diluted with broth so that 0.02 cc. of the broth contained 300,000, 5,000, and 700 organisms. The concentrations were determined by the nephelometer technique.

Rabbit eyes were anesthetized with local 0.5-percent tetracaine hydrochloride. They were sterilized with metaphen (1:4,000) and flushed thoroughly with sterile normal saline solution.

With a tuberculin syringe and a 26-gauge needle, two hundredths of a cc. of the broth containing 300,000 Staphylococcus aureus

organisms were inoculated into the center of 12 rabbit corneas, 12 anterior chambers, and into the vitreous of 12 rabbit eyes. Five-thousand organisms were inoculated into six corneas, six anterior chambers, and into the vitreous of six rabbit eyes. Seven-hundred organisms were inoculated into six corneas, six anterior chambers, and into the vitreous of six rabbit eyes.

Bacillus pyocyaneus was inoculated into the corneas, anterior chambers, and the vitreous in a similar manner, using the same number of eyes and the same concentration of organisms.

Three-hundred thousand organisms of Escherichia coli were inoculated into 10 corneas, 10 anterior chambers, and into the vitreous of 10 rabbit eyes. Five-thousand organisms were inoculated into six corneas, six anterior chambers, and into the vitreous of six rabbit eyes. Seven-hundred organisms were inoculated into six corneas, six anterior chambers, and into the vitreous of six rabbit eyes.

Cultures were taken from the corneas and anterior chambers of the rabbits that received corneal inoculation after 24, 48, and 72 hours. The material of the individual cultures was inoculated into brain-heart infusion broth and after 24 hours was transferred to blood-agar plates.

All corneas had been flushed previously with metaphen (1:4,000) and normal saline. Tetracaine hydrochloride (0.5 percent) was used for local anesthesia prior to obtaining the cultures.

The eyes that were inoculated intracamerally were prepared in a similar manner, and cultures were taken from the anterior chambers and vitreous at 24, 48, and 72 hours. The vitreous humor cultures were withdrawn with a 19-gauge needle.

The irises were cultured at the same time intervals. These cultures were inoculated into brain-heart infusion broth, and after 24 hours were transferred to blood-agar plates.

The eyes that were inoculated intravitreally were prepared in a similar manner, and cultures of the vitreous and anterior chambers were taken at 24, 48, and 72 hours. The retinas were cultured at the same time intervals. After 24 hours, the cultures were transferred to blood-agar plates.

## Results

It is apparent from Figures 1, 2, and 3 that, when organisms in higher concentrations were injected into the corneas, anterior chambers, and the vitreous, the infections extended into the adjoining structures more rapidly than when lower concentrations of the same organisms were used. The lower the concentration of organisms used, the more likely it was for the infection to be localized in the structures into which it had been inoculated. The corneas and anterior chambers possessed a greater ability to resist the infecting agent than the vitreous.

When 300,000 organisms of Staphylococcus aureus, Bacillus pyocyaneus, and Escherichia coli were inoculated into the corneas, the extension of the infection into the anterior chambers progressed rapidly. Within three days, the corneas were opaque and the anterior chambers filled with a plastic exudate. The eyes were under a high intraocular pressure. All of these eyes went on to complete disintegration.

When 5,000 of each type of organisms were inoculated into the corneas, the infection did not extend into the anterior chambers so rapidly. It was not until 48 hours after inoculation that all anterior chamber cultures were positive; 72 hours after inoculation, the corneas were markedly edematous and the anterior chambers were beginning to clear. The irises were only slightly cloudy. Seventy-two hours after 5,000 Escherichia coli organisms had been inoculated into the corneas, there were three negative anterior-chamber cultures.

It was interesting to note that when 700 organisms of Staphylococcus aureus and Escherichia coli were inoculated into the corneas, there was an extension of the infection

| Staphylococcus aureus (inoculated into*) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SIZE OF INOCULUM → | 300,000 ORGANISMS | | | 5,000 ORGANISMS | | | 700 ORGANISMS | | |
| HRS. CULTURES TAKEN → | 24 | 48 | 72 | 24 | 48 | 72 | 24 | 48 | 72 |
| * Cornea + | 12 | 12 | 12 | 6 | 6 | 6 | 5/1 | 0/6 | 0/6 |
| Cornea − | | | | | | | | | |
| Anterior chamber + | 10/2 | 12 | 12 | 5/1 | 6 | 6 | 5/1 | 0/6 | 0/6 |
| Anterior chamber − | | | | | | | | | |
| | 12 CORNEAS | | | 6 CORNEAS | | | 6 CORNEAS | | |
| * Anterior chamber + | 12 | 12 | 12 | 5/1 | 5/1 | 4/2 | 1/5 | 0/6 | 0/6 |
| Anterior chamber − | | | | | | | | | |
| Iris + | 12 | 12 | 12 | 5/1 | 5/1 | 4/2 | 0/6 | 0/6 | 0/6 |
| Iris − | | | | | | | | | |
| Vitreous + | 12 | 12 | 12 | 5/1 | 5/1 | 4/2 | 0/6 | 0/6 | 0/6 |
| Vitreous − | | | | | | | | | |
| | 12 ANT. CHAMBERS | | | 6 ANT. CHAMBERS | | | 6 ANT. CHAMBERS | | |
| * Vitreous + | 12 | 12 | 12 | 6 | 6 | 6 | 4/2 | 6/6 | 6/6 |
| Vitreous − | | | | | | | | | |
| Retina + | 12 | 12 | 12 | 5/1 | 5/1 | 5/1 | 4/2 | 4/2 | 6/6 |
| Retina − | | | | | | | | | |
| Anterior chamber + | 9/3 | 12 | 12 | 3/3 | 2/4 | 5/1 | 4/2 | 3/3 | 6/6 |
| Anterior chamber − | | | | | | | | | |
| | 12 VITR. | | | 6 VITR. | | | 6 VITR. | | |

Fig. 1 (Maylath and Leopold). Ability to recover Staphylococcus aureus inoculated into ocular tissues and fluids.

into the anterior chambers within 24 hours, and in the succeeding 24 hours all anterior chambers and corneal cultures were negative. The hypopyons were not severe and gradually cleared. Cultures taken from the anterior chambers at 48 hours were negative although the hypopyons existed. The corneas lost their edema, and the anterior chambers cleared within 72 hours.

The anterior chambers and corneas were able to overcome 5,000 organism inoculums of Staphylococcus aureus and Escherichia coli completely. The B. pyocyaneus was most resistant. This was evident also following the use of higher concentrations of the organisms, that is, 5,000/inoculum. The pyocyaneous was not inhibited as readily by the anterior chamber, iris, and vitreous as were the staphylococci and Escherichia coli.

The corneas were less resistant than the anterior chambers and irises to all organisms inoculated in 5,000-inoculum concentration. When inoculums of 5,000 organisms and over were employed, they were not overcome in the corneas nor the anterior chambers during the period of observation used in this study.

In the lowest concentration, the anterior chambers had a greater ability than the corneas to overcome the infecting agent.

The data revealed that extension of infection from the anterior chamber to the vitreous was less rapid than from the vitreous to the anterior chamber. This may be due to the aqueous circulating away from the vitreous, and the phagocytic actions of the iris endothelial cells. The same dose of organisms that could be overcome by the anterior chamber when introduced into the vitreous produced a progressive inflammation. Apparently only the anterior chamber is provided with an effective phagocytic and anti-infectious system.

The vitreous appeared to be an excellent

culture media for any organism in all concentrations. Lower concentrations slightly delayed the onset of a panophthalmitis.

It is also evident that negative cultures can be obtained from the anterior chamber in the presence of hypopyon and severely infected posterior vitreous humor. This was especially noticeable when 700 staphylococcus and pyocyaneous organisms were inoculated into the vitreous. Cultures taken in 48 hours from the vitreous were positive in 100 percent of the staphylococcus-inoculated eyes and in four out of six of those infected with B. pyocyaneus. However, the anterior chambers were negative in one third of the staphylococci-injected eyes after 48 hours, and in 50 percent of the pyocyaneus-injected eyes.

The Staphylococcus aureus organism was responsible for the most virulent infection in this study. Bacillus pyocyaneus and Escherichia coli were less virulent.[1]

## Discussion

The results point out the ability of the anterior chamber, cornea and the vitreous to resist infecting agents. The anterior chambers were superior to the corneas, and in this regard the vitreous had poor anti-infection ability.

The anti-infection ability of the anterior chamber may be due to the surrounding iris cells and readily available circulation. Friedenwald and Pierce[2] have shown that inert particles, such as India ink, if injected into the anterior chamber, are readily absorbed by the iris endothelial cells. Bacteria introduced into the anterior chamber may be similarly removed by these same cells. Burky and Friedenwald[3] found that one hour after the injection of virulent staphylococci into the anterior chamber, cultures of the aqueous were sterile and the iris endothelial cells were loaded with organisms.

Spread of infection occurred more rapidly

**Bacillus Pyocyaneous (inoculated into *)**

| SIZE OF INOCULUM → | 300,000 ORGANISMS | | | 5,000 ORGANISMS | | | 700 ORGANISMS | | |
|---|---|---|---|---|---|---|---|---|---|
| HRS. CULTURES TAKEN → | 24 | 48 | 72 | 24 | 48 | 72 | 24 | 48 | 72 |
| * Cornea + − | 12 | 12 | 12 | 6 | 6 | 6 | 6 | 6 | 3/3 |
| Anterior chamber + − | 9/3 | 12 | 12 | 3/3 | 6 | 6 | 4/2 | 4/2 | 1/5 |
| | 12 CORNEAS | | | 6 CORNEAS | | | 6 CORNEAS | | |
| * Anterior chamber + − | 12 | 12 | 12 | 6 | 6 | 6 | 4/2 | 6 | 3/3 |
| Iris + − | 12 | 12 | 12 | 6 | 6 | 6 | 2/4 | 5/1 | 1/5 |
| Vitreous + − | 12 | 12 | 12 | 3/3 | 6 | 6 | 1/5 | 5/1 | 1/5 |
| | 12 ANT. CHAMBERS | | | 6 ANT. CHAMBERS | | | 6 ANT. CHAMBERS | | |
| * Vitreous + − | 12 | 12 | 12 | 6 | 6 | 6 | 6 | 5/1 | 5/1 |
| Retina + − | 12 | 12 | 12 | 6 | 6 | 6 | 2/4 | 3/3 | 2/4 |
| Anterior chamber + − | 9/3 | 9/3 | 10/2 | 6 | 6 | 6 | 2/4 | 2/4 | 2/4 |
| | 12 VITR. | | | 6 VITR. | | | 6 VITR. | | |

Fig. 2 (Maylath and Leopold). Ability to recover Bacillus pyocyaneus inoculated into ocular tissues and fluids.

| Escherichia coli (inoculated into *) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SIZE OF INOCULUM → | 300,000 ORGANISMS | | | 5,000 ORGANISMS | | | 700 ORGANISMS | | |
| HRS. CULTURES TAKEN → | 24 | 48 | 72 | 24 | 48 | 72 | 24 | 48 | 72 |
| * Cornea + | 10 | 10 | 10 | 5/1 | 6 | 6 | 6 | 1/3 | 6 |
| Anterior chamber + | 10 | 10 | 10 | 4/2 | 6 | 3/3 | 5/1 | 6 | 6 |
| | 10 CORNEAS | | | 6 CORNEAS | | | 6 CORNEAS | | |
| * Anterior chamber + | 10 | 10 | 10 | 6 | 6 | 6 | 1/5 | 6 | 6 |
| Iris + | 10 | 10 | 10 | 5/1 | 5/1 | 4/2 | 1/5 | 6 | 6 |
| Vitreous + | 10 | 10 | 10 | 4/2 | 5/1 | 4/2 | 1/5 | 6 | 6 |
| | 10 ANT. CHAMBERS | | | 6 ANT. CHAMBERS | | | 6 ANT. CHAMBERS | | |
| * Vitreous + | 10 | 10 | 10 | 6 | 6 | 6 | 6 | 4/2 | 6 |
| Retina + | 10 | 10 | 10 | 6 | 6 | 6 | 6 | 4/2 | 6 |
| Anterior chamber + | 10 | 10 | 10 | 6 | 6 | 6 | 5/1 | 4/2 | 6 |
| | 10 VITR. | | | 6 VITR. | | | 6 VITR. | | |

Fig. 3 (Maylath and Leopold). Ability to recover Escherichia coli inoculated into ocular tissues and fluids.

from the vitreous to the anterior chamber than in the reverse direction. This is probably due to two mechanisms, the lack of anti-infection properties of the vitreous and the flow of intraocular fluids from the posterior to the anterior chamber.

This study demonstrated the possibility of producing negative anterior chamber cultures in the presence of an actively infected vitreous humor.

## II. Treatment of Intraocular Infections with Antibiotics and Cortisone, Alone and Combined

Infections were produced in normal rabbit eyes in an effort to evaluate the role of cortisone in the therapy of intraocular infections.

### Method

The infections were produced by inoculating 5,000 Staphylococcus aureus organisms into the corneas, anterior chambers, and the vitreous. In another series, 150,000 Staphylococcus aureus organisms were inoculated into the anterior chambers.

In this study, 642 eyes were used in producing the three types of infection and as controls: 372 eyes were treated either subconjunctivally, systemically, or intravitreously with cortisone and antibiotics combined, with antibiotics and cortisone alone; 270 eyes were used as controls in their respective series.

In one series, treatment was instituted four hours after the inoculation of the organism, and in the other 12 hours after inoculation.

Penicillin, subconjunctivally, one million units dissolved in 0.75 cc. of water, was used to treat 42 eyes. One subconjunctival injection was given daily for four days. In each instance the right eye was treated and the left was the control eye receiving only saline flushes at the same time interval.

Therapy was instituted four hours after inoculation in six corneal, six anterior cham-

bers, six vitreous lesions produced by 5,000 organisms and in six anterior chamber lesions produced by inoculating 150,000 organisms into the anterior chamber. In another series, six corneal and six vitreous infections produced by inoculating 5,000 organisms were treated similarly 12 hours after inoculation. The left eye of each of these rabbits was inoculated similarly, but received no antibiotic therapy.

Another 42 eyes were treated with one million units of penicillin in 0.75 cc. of water and 12.5 mg. of cortisone subconjunctivally. In this group, as before, the right eyes were treated and the left eyes were untreated. Subconjunctival injections in one group were started four hours after inoculation and in the other 12 hours after inoculation and continued daily for four days. The same number of eyes with the same types of infection were used as described in the previous paragraph.

In another 42 eyes with similarly induced infection, the same number of eyes were treated with 12.5 mg. of cortisone subconjunctivally. The right eyes were treated and the left untreated. In one group, therapy began four hours and in the other 12 hours after inoculation.

The 42 eyes of 21 rabbits were treated systemically with penicillin alone. One million units of penicillin in suspension were given intramuscularly once a day for three successive days. In one group of 24 eyes, treatment began four hours after inoculation, and in the other 18, 12 hours after inoculation. The same type of infections with similar distribution were used as previously described.

Another 42 eyes (21 rabbits) were treated with penicillin and cortisone acetate systemically. One million units of penicillin in suspension were given intramuscularly once a day for three days. One hundred mg. of cortisone acetate were given intramuscularly three times a day at eight-hour intervals for the first 24 hours; and 100 mg. twice a day at 12-hour intervals for the next 24 hours; and 100 mg. once daily thereafter. The combined therapy in one group of 24 eyes began four hours after inoculation and in the other 18 eyes, 12 hours after inoculation (figs. 4 and 5).

Forty-two eyes (21 rabbits) were treated systemically with cortisone acetate alone. It was administered as previously described. In one group of 24 eyes, treatment was started four hours after inoculation, and in the other 18 eyes, 12 hours after inoculation.

Eighteen eyes (nine rabbits) were inoculated similarly but untreated and were used as controls for the group treated systemically.

Twelve eyes of 12 rabbits were treated intravitreously with penicillin alone. Five-thousand units of penicillin in 0.1 cc. of water were injected into the vitreous once. Six of these eyes were treated four hours after inoculating 5,000 Staphylococcus aureus organisms into the vitreous and six were treated 12 hours after inoculation. The right eyes of the rabbits were treated, and the left untreated although similarly inoculated.

Twelve eyes of 12 rabbits were treated intravitreously with 5,000 units of penicillin in water and 2.5 mg. of cortisone acetate suspension combined. Only one injection was given. Six eyes were treated four hours after inoculation of 5,000 staphylococci and six were treated 12 hours after inoculation. The right eyes were treated and the left similarly inoculated untreated.

Eighteen eyes were treated subconjunctivally with 1.2 mg. of chloromycetin in 0.5 cc. of water. Therapy was instituted four hours after inoculation, in six corneal and six vitreous infections produced by inoculating 5,000 Staphylococcus aureus organisms, and in six anterior-chamber infections produced by inoculating 150,000 Staphylococcus aureus organisms into the anterior chamber. One subconjunctival injection was given for four successive days. The right eyes were treated and the left untreated (fig. 6).

Combined subconjunctival treatment with cortisone acetate and chloromycetin was used

| INOCULATION: 5,000 ORGANISMS Staphylococcus Aureus | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TREATMENT → ↓ | 4 Hrs. after Inoculation | | | | | | 12 Hrs. after Inocul. | | | |
| | CORNEAS | | ANTERIOR CHAMBERS | | VITREOUS | | CORNEAS | | VITREOUS | |
| | NUMBER OF EYES | | | | | | | | | |
| | CLEARED | TREATED | CLEARED | TREATED | CLEARED | TREATED | CLEARED | TREATED | CLEARED | TREATED |
| SUBCONJUNCTIVALLY: | | | | | | | | | | |
| Penicillin | 6 | 6 | 6 | 6 | 2 | 6 | 2 | 6 | 0 | 6 |
| Cortisone and Penicillin | 6 | 6 | 6 | 6 | 6 | 6 | 2 | 6 | 0 | 6 |
| Cortisone | 6 | 6 | 6 | 6 | 1 | 6 | 0 | 6 | 0 | 6 |
| SYSTEMICALLY: | | | | | | | | | | |
| Penicillin | 6 | 6 | 6 | 6 | 6 | 6 | 0 | 6 | 0 | 6 |
| Cortisone and Penicillin | 6 | 6 | 6 | 6 | 6 | 6 | 0 | 6 | 0 | 6 |
| Cortisone | 6 | 6 | 6 | 6 | 0 | 6 | 0 | 6 | 0 | 6 |
| INTRAVITREOUSLY: | | | | | | | | | | |
| Penicillin | | | | | 5 | 6 | | | 0 | 6 |
| Cortisone and Penicillin | | | | | 4 | 6 | | | 0 | 6 |
| Cortisone | | | | | 0 | 6 | | | 0 | 6 |

Fig. 4 (Maylath and Leopold). Effect of using penicillin and cortisone (alone or combined) on intraocular infections produced by inoculation with 5,000 Staphylococcus aureus organisms.

in another 18 eyes; 12.5 mg. of cortisone acetate and 1.2 mg. of chloromycetin was given once daily for four successive days. The same type of infections and in the same distribution were used as in the preceding paragraph. Treatment was started four hours after inoculation. The right eyes were treated and the left eyes received no treatment.

| Inoculation : Staphylococcus Aureus 150,000 ORGANISMS IN ANTERIOR CHAMBERS | | | | |
|---|---|---|---|---|
| TREATMENT STARTED → 4 HOURS → 12 HOURS | | | | |
| AFTER INOCULATION ↓ | NUMBER OF EYES | | | |
| | CLEARED | TREATED | CLEARED | TREATED |
| SUBCONJUNCTIVALLY: | | | | |
| Penicillin | 6 | 6 | 4 | 6 |
| Cortisone and Penicillin | 6 | 6 | 2 | 6 |
| Cortisone | 5 | 6 | 2 | 6 |
| SYSTEMICALLY: | | | | |
| Penicillin | 6 | 6 | 4 | 6 |
| Cortisone and Penicillin | 6 | 6 | 4 | 6 |
| Cortisone | 3 | 6 | 0 | 6 |

Fig. 5 (Maylath and Leopold). Effect of using penicillin (alone or combined) on intraocular infections produced by inoculation with 150,000 Staphylococcus aureus organisms.

Eighteen inoculated eyes of nine rabbits were treated systemically with chloromycetin alone; 0.5 gm. of chloromycetin was given intramuscularly every four hours for four days. Similar infections with the same distribution as described previously were used. Treatment began four hours after inoculation.

In another 18 eyes, systemic therapy with chloromycetin and cortisone combined was used. Chloromycetin was given in 0.5-gm. doses every four hours for four successive days. Cortisone acetate was given systemically as previously described.

For the systemically treated eyes, six eyes (three rabbits) were used as controls using the same organisms from the same culture.

Six eyes were treated intravitreously with chloromycetin alone. The treatment began four hours after 5,000 Staphylococcus aureus organisms had been inoculated into the vitreous; 250 gm. of chloromycetin in 0.1 cc. of water was injected into the vitreous. The

right eyes were treated and the left untreated.

Six more eyes were treated with chloromycetin and cortisone combined; 250 gm. of chloromycetin and 2.5 mg. of cortisone acetate suspension were injected into the vitreous, four hours after the inoculation of 5,000 Staphylococcus aureus organisms.

## Results

The results of treatment with penicillin and cortisone alone and with the combined treatment of penicillin and cortisone, both subconjunctival and systemic, may be seen in Figures 4 and 5 and Figures 8, 9, 10, and 11.

The eyes were graded as follows:

### *Corneas graded*

1. Central corneal infiltration and edema, anterior chamber grossly clear, iris clearly seen and no pericorneal injection was equal to a 25-percent lesion.
2. Entire cornea uniformly infiltrated and edematous, iris clearly seen, no hypopyon, and slight pericorneal injection was equal to a 50-percent lesion.
3. Marked corneal infiltration and edema, ulceration of the cornea, hypopyon, anterior chamber cloudy, and marked pericorneal and conjunctival inflammation was equal to a 75-percent lesion.

### *Anterior chambers graded*

1. Slight haze or flare in anterior chamber, iris clear and clearly seen, and no hypopyon was equal to a 25-percent lesion.
2. Anterior chamber more hazy, four-plus flare, and muddy edematous iris was equal to a 50-percent lesion.
3. Anterior chamber milky white, hypopyon formation, no view of the iris, and a marked ciliary flush was equal to a 75-percent lesion.
4. Anterior chamber filled with plastic exudate, no view of the iris, corneal edema, marked ciliary congestion, and conjunctival inflammation was equal to a 100-percent lesion.

### *Vitreous graded*

1. Slight vitreous haze and the details of the fundus were clearly visible was equal to a 25-percent lesion.
2. Moderate vitreous cloudiness with no fundus detail, but an occasional blood vessel could be seen, was equal to a 50-precent lesion.
3. Red fundus reflex with no fundus detail was equal to a 75-percent lesion.
4. Gray fundus reflex was equal to a 100-percent lesion.

It is apparent from Figure 4 that all the corneas cleared in which therapy had been started four hours after inoculation. Of the corneas in which treatment had been started 12 hours after inoculation, only four recovered fully; two treated with penicillin alone subconjunctivally and two treated with cortisone and penicillin subconjunctivally. All of the control eyes were lost in eight days.

It is evident from Figures 4 and 8 that corneal lesions treated with penicillin and cortisone combined, either subconjunctivally or systemically, responded similarly to those treated with penicillin alone or superiorly to those treated with cortisone alone. The inflammatory reaction with the combined treatment was not quite as severe as when penicillin alone had been used. Cortisone used alone, either subconjunctivally or systemically, resulted in the least favorable reaction.

The corneas of rabbits in which subconjunctival treatment was started four hours after inoculation showed a more severe inflammatory reaction than those treated systemically. This may have been due to the irritation of the large subjunctival injection of the medication.

It is apparent from Figures 4 and 10 that all infections of the anterior chambers produced by inoculating 5,000 Staphylococcus aureus organisms and in which treatment was instituted four hours after inoculation, responded very readily to all forms of therapy within five days.

The systemically treated eyes showed less inflammatory reaction than those treated subconjunctivally. The severity of the reaction in subconjunctivally treated lesions was due possibly to the irritation of the injections.

In the systemically treated eyes, there was no significant difference in the severity of the reaction when treated wtih penicillin alone, with penicillin and cortisone combined, or with cortisone alone. The maximum severity of the infection was reached within

| Staphylococcus Aureus → | INOCULATION* 5,000 ORGANISMS | | | | 150,000 ORGANISMS | |
|---|---|---|---|---|---|---|
| TREATMENT 4 HOURS AFTER INOCULATION ↓ | *CORNEAS | | *VITREOUS | | *ANTERIOR CHAMBERS | |
| | NUMBER OF EYES | | | | | |
| | CLEARED | TREATED | CLEARED | TREATED | CLEARED | TREATED |
| SUBCONJUNCTIVALLY | | | | | | |
| Chloromycetin | 2 | 6 | 0 | 6 | 4 | 6 |
| Chloromycetin and Cortisone | 5 | 6 | 1 | 6 | 5 | 6 |
| SYSTEMICALLY | | | | | | |
| Chloromycetin | 5 | 6 | 0 | 6 | 6 | 6 |
| Chloromycetin and Cortisone | 6 | 6 | 4 | 6 | 6 | 6 |
| INTRAVITREOUSLY | | | | | | |
| Chloromycetin | | | 0 | 6 | | |
| Chloromycetin and Cortisone | | | 0 | 6 | | |

Fig. 6 (Maylath and Leopold). Effect of using chloromycetin and cortisone (alone or combined) on intraocular infections produced by inoculation with 5,000 or with 150,000 Staphylococcus aureus organisms.

48 hours. This subsided gradually and cleared within five days.

This spontaneous clearing of the anterior chambers even in the control eyes indicated the great ability of the anterior chambers to overcome infection. It also demonstrated that systemically and subconjunctivally administered cortisone did not interfere significantly with the ability of the anterior chamber to overcome this type of staphylococcus inoculation.

It is indicated in Figures 5 and 10 that all infections produced by inoculating 150,000 Staphylococcus aureus organisms into the anterior chambers and instituting therapy four hours after inoculation did not respond to treatment as rapidly as did the infections in the previous group. There was one eye out of six treated subconjunctivally with cortisone alone and three out of six treated systemically with cortisone alone that did not respond to treatment. All of the control eyes were lost in eight days.

Figure 10 demonstrates that the eyes treated subconjunctivally or systemically with penicillin and cortisone combined cleared as rapidly as those similarly treated with penicillin alone. The inflammatory reaction in the eyes treated subconjunctivally or systemically with the combined therapy of penicillin and cortisone was not as severe as it was in the eyes treated similarly with penicillin alone.

The inflammatory reaction in the eyes treated subconjunctivally or systemically with penicillin alone was not as severe as in the eyes treated similarly with cortisone alone.

It is evident from Figure 5 that treatment instituted 12 hours after inoculating 150,000 Staphylococcus aureus organisms into the anterior chambers was not as satisfactory as when therapy was instituted four hours after inoculation. Four out of six eyes cleared with subconjunctival penicillin alone, two out of six with cortisone and penicillin combined,

and two out of six with cortisone alone.

In the eyes treated systemically with penicillin alone, the infection cleared in four out of six eyes, and in four of six with the combined treatment of penicillin and cortisone. The eyes treated intramuscularly with cortisone alone did not respond to the treatment.

It can be seen in Figure 10 that the eyes treated subconjunctivally with penicillin and cortisone combined responded to treatment more rapidly and with less severe inflammatory reaction than those treated with penicillin or cortisone alone. The most severe inflammatory reactions were observed in the eyes treated subconjunctivally only with cortisone.

When cortisone and penicillin combined were given intramuscularly, the end results were similar to therapy with penicillin alone; however, the inflammatory reaction was less with the combined therapy. Cortisone alone was the least effective, only reducing the inflammatory reaction and delaying slightly the eventual destruction of the globes. Here, again, the systemic treatment was more satisfactory than subconjunctival. In the control eyes of this group, the infection progressed slowly, and within eight days the infection was overwhelming.

In Figure 4 may be seen the results of treatment after inoculation of 5,000 Staphylococcus aureus organisms into the vitreous and the institution of therapy four and 12 hours after inoculation.

In the eyes treated subconjunctivally four hours after inoculation of the organisms, two out of six eyes cleared with penicillin alone, one out of six eyes with cortisone alone, and all six eyes cleared with the combined treatment of penicillin and cortisone.

In the eyes treated systemically with penicillin alone or with penicillin and cortisone combined, all six eyes cleared, but with cortisone alone given intramuscularly, there was no response to treatment. Five out of six eyes treated intravitreously with penicillin cleared. Four out of six eyes treated with cortisone and penicillin cleared. Intravitreously administered cortisone cleared no eyes.

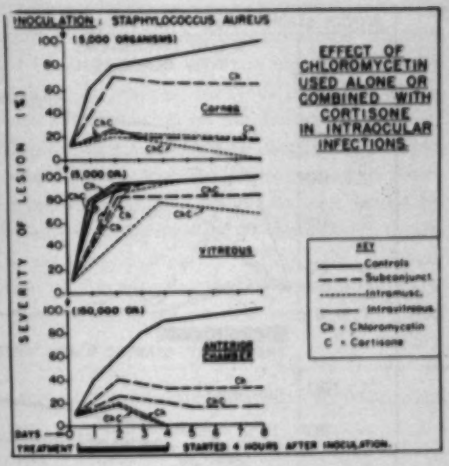


Fig. 7 (Maylath and Leopold). Effect of chloromycetin and cortisone (alone or combined) on intraocular infection with Staphylococcus aureus.

All treatment employed 12 hours after inoculation failed to clear any eyes. The infections were overwhelming, and all were lost within 11 to 12 days (figs. 9 and 11).

Direct intravitreal injection of penicillin four hours after inoculation of organisms did about as well as systemically administered massive doses of penicillin and penicillin and cortisone combined. Cortisone injected intravitreously with penicillin did not enhance the effectiveness of the penicillin. Subconjunctivally administered penicillin alone was not as effective as the other routes of administration but when combined with cortisone, the end results were equal to those obtained by the other methods.

When therapy was instituted 12 hours after inoculation, all methods failed.

The results of treatment with chloromycetin alone and combined with cortisone may be seen in Figures 6 and 7.

When chloromycetin was given by subconjunctival injection, two out of six corneas cleared within four days, and when combined with cortisone, five out of six eyes cleared within three days. In the eyes treated systemically with chloromycetin, five out of

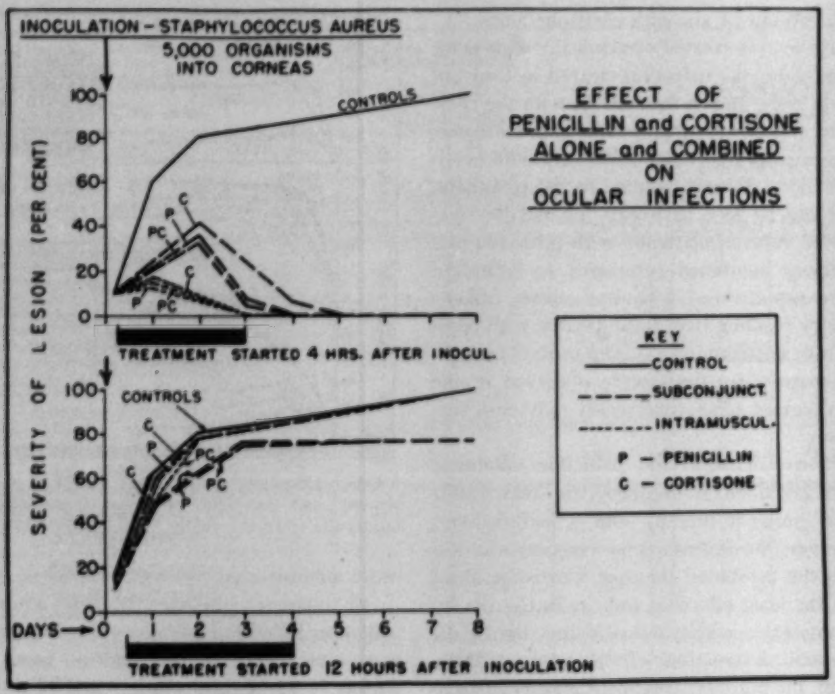


Fig. 8 (Maylath and Leopold). Effect of penicillin and cortisone (alone or combined) on intraocular infection with Staphylococcus aureus.

six corneas cleared in four days and when combined with cortisone, all six eyes were clear within three days.

The combined therapy of cortisone and chloromycetin given subconjunctivally was more effective in overcoming the infection than chloromycetin alone. The systemic administration of chloromycetin was more effective than the subconjunctival and when combined with cortisone was even more effective. The inflammatory reaction in the combined therapy of chloromycetin and cortisone was much less than with chloromycetin alone. All the control eyes became completely opaque and many perforated.

Four out of six anterior chamber infections treated with chloromycetin subconjunctivally cleared in four days, and when chloromycetin was combined with cortisone, five out of six eyes cleared in five days.

In the systemically treated anterior chamber infections, all eyes cleared within four days whether the treatment was with chloromycetin alone or combined with cortisone.

The systemic treatment was more rapid in clearing the anterior chamber infections than the subconjunctival. The combined therapy by both routes reduced the inflammatory reaction more rapidly than alone. All control eyes became progressively worse (fig. 8).

Of all the vitreous infections, only one treated subconjunctivally with chloromycetin and cortisone combined, and four treated systemically with the combined treatment recovered from the infection. The control eyes in this group were all lost eventually (figs. 6 and 8).

## Discussion

It is apparent from these studies that, in corneal, anterior-chamber, and vitreous infections produced by Staphylococcus aureus organisms, cortisone administered subconjunctivally, systemically, or intravitreally in combination with antibiotics has no harmful influence, provided the inoculum was not too great to be overcome by the resistance of the eye and the infecting agent was susceptible to the antibiotic employed.

It is known that cortisone abolishes or decreases the reaction of the organisms to "stress."[4] In pathologic conditions in which the allergic reaction is so marked and plays the major role in the whole disease process, there seems to be little question about the usefulness of cortisone.

In other cases, however, in which the pathogenic agent is known and the reaction of the organisms to stress simply represents a defense process, likely to limit and to retard the extension of the disease, the inhibition of such a reaction by means of cortisone would appear to be harmful instead of beneficial, since all that would happen would be a transient attenuation of the allergic or inflammatory symptoms without the elimination of the agent acting as a stimulus. If the stimulating agent is not removed in these conditions, the allergic or inflammatory manifestations will undoubtedly recur as soon as the administration of cortisone has been suspended.

It is indicated in these studies that, where there was great ability of the tissues to overcome infection, such as in the anterior chamber, cortisone alone did not interfere sig-

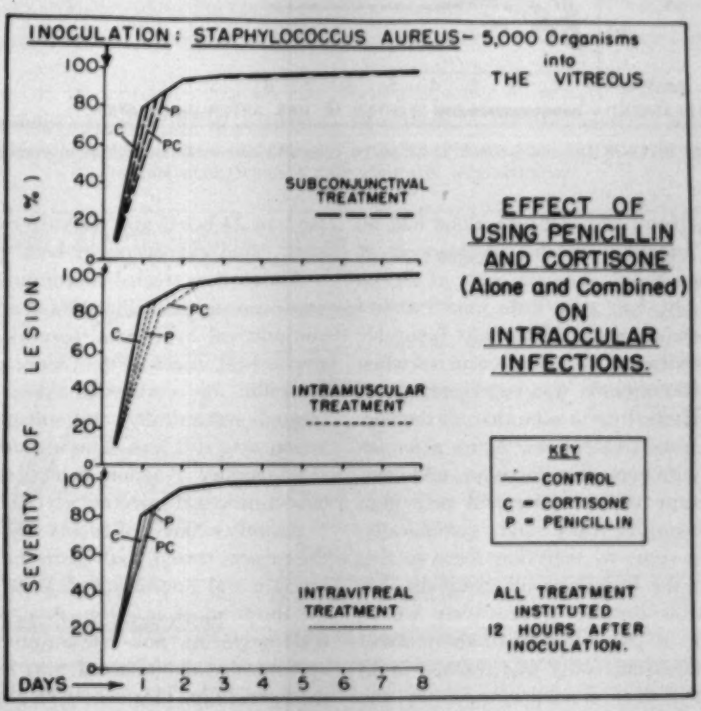


Fig. 9 (Maylath and Leopold). Effect of penicillin and cortisone (alone or combined) on intraocular infections with Staphylococcus aureus.

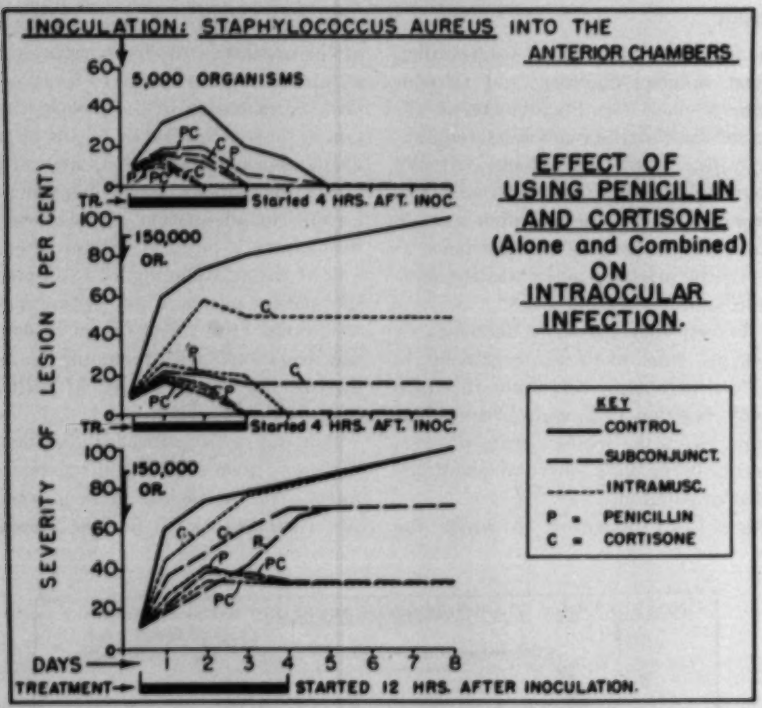


Fig. 10 (Maylath and Leopold). Effect of penicillin and cortisone (alone or combined) on intraocular infections with Staphylococcus aureus.

nificantly. However, cortisone alone had no favorable influence on the development of vitreous infections. The vitreous, as shown in this study, had very little innate ability to overcome infection. The only favorable therapy of vitreous infections occurred when an effective antibiotic was employed.

It was interesting to note that all the corneal infections treated four hours after inoculation with penicillin, cortisone, and combined therapy of cortisone and penicillin, given subconjunctivally and systemically, showed no signs of infection three to five days from the beginning of treatment, but their controls became progressively worse. The height of the infection in the corneas treated subconjunctivally was reached in 48 hours, but in those treated systemically, the inflammatory reaction was less, reaching its peak in 24 hours and thereafter there was a very rapid regression in both (fig. 11).

The corneas treated subconjunctivally with cortisone and penicillin showed a less marked conjunctival hyperemia, corneal edema, and pericorneal injection than those treated with penicillin or cortisone alone, but when treated systemically, the inflammatory reaction was still less. This demonstrated the inflammatory reaction associated with the subconjunctival injection of these agents.

A similar course of events was observed in the corneas treated with cortisone and chloromycetin and chloromycetin alone except that the duration of infection was much longer. Chloromycetin, both subconjunctivally and systemically administered, was less effective than penicillin. This was to be expected. The staphylococcus used in this study was more

susceptible to penicillin than to chloromycetin by in vitro testing.

The longer any of the infections were allowed to progress without treatment, the less effectual was the eventual therapy.

The simultaneous administration of cortisone and antibiotics seemed to exert an ameliorating influence on the course of the infection by causing an attenuation of the inflammatory signs. This has been demonstrated previously in ophthalmology by Lepri.[5]

It has been demonstrated by others, Woods,[11a,11b] Smadel,[12] Mogabgag, et al.,[13] Spain and Molomut,[14] Rome, et al.,[15] and Leopold[16] that quicker relief of symptoms occurred when these two agents were used in combination. Woods[11a] and Spain[14] have shown that better results may be obtained in the treatment of infection with cortisone combined with antibiotics. Selye[4] has shown that cortisone markedly delays the course of infection in mice caused by Staphylococcus aureus.

The extent of the corneal opacities and leukomas in those eyes exposed to cortisone therapy was no greater than those observed in the eyes of animals which received only antibiotics. In many cases, the opacities were smaller and less dense. The reduction in density and extent of scar formation by the use of cortisone has been reported repeatedly.[6-10]

The favorable effect of cortisone and massive doses of antibiotics used early in the course of experimental ocular infections as noted in this study has been recorded previously.[17-23] The necessity for early therapy of vitreous infections was impressive in this study.

Cessation of cortisone and antibiotic treatment caused neither further extension of the infection nor recurrence. Cortisone did not interfere with the action of the antibiotics but rather enhanced their effect by diminishing the intensity of the inflammation, and thus favoring the course of healing. This has been noticed recently by Karlson and Garner.[24]

It is apparent from this investigation that the simultaneous treatment with cortisone and antibiotics in massive doses has a slight advantage in the treatment of acute infections over the antibiotic therapy alone. The

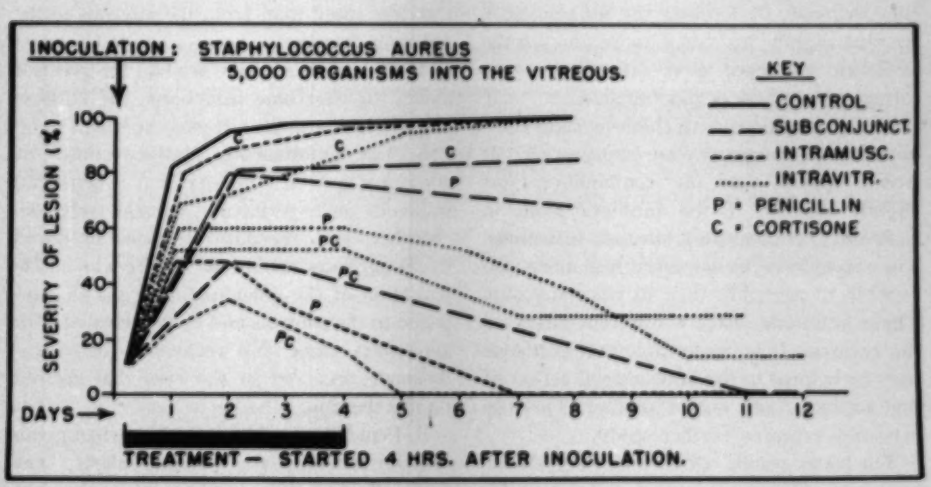


Fig. 11 (Maylath and Leopold). Effect of penicillin and cortisone (alone or combined) on infection produced by inoculation of 5,000 Staphylococcus aureus organisms into the vitreous.

employment of cortisone alone is not advisable, since the infecting agent is not to any extent influenced by the action of the hormones.

It must be stressed, however, that this should in no way be construed as a recommendation for the use of cortisone in combination with antibiotics for the therapy of all intraocular infections. This study simply indicates that under certain conditions cortisone is not harmful and may reduce the inflammatory reaction and lessen the eventual tissue damage associated with intraocular infection. The most important condition is that the infecting organism must be susceptible to the antibiotic chosen for therapy. Positive cultures of intraocular infections are difficult to obtain. Even when they are available, in vitro testing of organism susceptibility is not always applicable to clinical disease.

If the organism is not susceptible to the chosen antibiotic, regardless of whether cortisone is employed, the eye will be lost. If the antibiotic selected is the proper one, the use of cortisone may lessen some of the ocular destruction induced by inflammation.

If the initial antibiotic proves unsuccessful, cortisone, by limiting the inflammatory reaction slightly, may allow more time for the antibiotic employed next (if effective) to salvage more of the ocular function.

The observations with chloromycetin combined with cortisone are interesting. It would appear that the combination was slightly superior to the antibiotic alone in controlling corneal and vitreous infections. The staphylococcus employed was more susceptible to penicillin than to chloromycetin. These antibiotics have a different effect on the bacteria. It is conceivable that cortisone may be helpful to the antibacterial action of one antibiotic and not to another. This observation requires further study.

The better results obtained by the systemic route of administration of chloromycetin compared to the subconjunctival route are probably due to the low concentration injected subconjunctivally, and to the excellent intraocular penetration of chloromycetin when systemically administered.

## Summary

1. When high concentrations of organisms, that is, 300,000 per 0.2 cc. of broth, were inoculated into the corneas, anterior chambers, and vitreous, a virulent panophthalmitis was produced within 24 to 48 hours, and destruction of the eye took place within 72 hours regardless of the site of inoculation.

2. When lower concentrations of organisms, that is 5,000 per 0.2 cc. of broth, were inoculated into the corneas, anterior chambers, and vitreous, a panophthalmitis resulted in 72 hours. The infections were most severe following intravitreal inoculations and less intense when the anterior chamber was the site of inoculation.

3. When still lower concentrations of inoculum were used, that is 700 organisms per 0.02 cc. of broth, the infections were overcome by the corneas and the anterior chambers within 24 hours but were never halted by the vitreous.

4. The rate of extension of the infection from the anterior chamber to the vitreous was less rapid than from the vitreous to the anterior chamber.

5. The anterior chambers had the greatest ability to overcome infections, the corneas slightly less, and the vitreous the least.

6. The simultaneous administration of cortisone and an antibiotic had a beneficial influence on experimental corneal, anterior-chamber, and vitreous infections produced by Staphylococcus aureus. There was an attenuation of the inflammatory signs as compared to the controls and to eyes treated with antibiotics alone. No recurrence or recrudescence occurred in the eyes that cleared on this therapy.

7. Penicillin or chloromycetin, when given subconjunctivally or intramuscularly, was more effective than cortisone alone, but not superior to the combined treatment of cortisone and antibiotics. The inflammatory signs

were less marked in the combined treatment.

8. Penicillin, when given alone or in combination with cortisone, was more effective than chloromycetin given similarly against infection due to a susceptible strain of Staphylococcus aureus.

*16th and Spring Garden Streets (30).*

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# THE MORGAGNIAN CATARACT

## Its characteristics and surgery

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During the past half century the incidence of morgagnian cataract in this country has so declined that this form of hypermature cataract is looked upon as an extreme rarity by many American ophthalmologists. Consequently the surgeon who is faced with treating such a case may approach the operating table with at least a little less than his usual confidence. The purpose of this paper is to present the salient characteristics of the morgagnian cataract and its surgery together with impressions based on my experience with 125 morgagnian cataracts.

### Characteristics

The morgagnian cataract is that form of senile hypermature cataract in which the brown sclerosed nucleus lies in a capsular sac of milky white liquefied cortex.

Elliot, according to Vail,[1] noted that 17 percent of all cataract cases in Madras, India, were morgagnian. In the Kurji (Bihar, India) Eye Hospital, I recently found an incidence of approximately 30 percent among candidates for cataract surgery.

The low incidence of morgagnian cataract in the United States is attributed to the fact that present-day eye surgeons usually recommend extraction of a cataract once it has reached maturity—even if the vision in the other eye is still adequate.

In the past—and occasionally even now—the individual with maintained serviceable vision in one eye and cataract formation in the other was inclined to reconcile himself to the status quo rather than submit to surgery with likelihood of continued monocular vision. As a result such cataracts frequently progressed to the morgagnian stage of hypermaturity.

In my experience, a common factor in permitting a cataract to progress to this stage is a previous successful cataract extraction in the other eye. The patient is satisfied with his newly acquired vision—though monocular—and does not return to the surgeon for periodic follow-up. Another type of patient is the one in whom previous cataract surgery has had unfortunate results—the patient is afraid to submit his remaining eye, though blind, to surgery.

### Diagnosis

The diagnosis of morgagnian cataract involves differentiation from the other more common forms of cataract. A convenient classification of senile cataract is one that is based on the relative amount of lens substance that has become opaque. Such a progressive classification is:

1. Incipient cataract
2. Immature cataract
3. Intumescent cataract
4. Mature cataract
5. Hypermature cataract
   a. Shrunken type
   b. Morgagnian type

The incipient and immature forms are not easily confused with the morgagnian cataract, for they contain obviously uninvolved transparent cortex—the incipient more so than the immature form.

The intumescent cataract is most frequently confused with the morgagnian cataract. The differentiating characteristics of the intumescent form are:

1. The anterior chamber is shallow. (However, in the morgagnian cataract the chamber may be shallow too.)

2. Frequently an iris shadow is still cast—an indication of transparent cortex beneath the anterior capsule that can be verified with the slitlamp.

3. The lens has a definite silky white sheen with distinct radial or sector markings.

4. When opened, the intumescent cataract

reveals silvery, fluffy cortical material instead of milky white liquefied cortex.

The mature cataract presents a chamber of normal depth, no iris shadow, extension of the cataractous changes to immediately beneath the anterior capsule, a grayish or yellowish white color, and retention of radial or sector markings. The brownish nucleus will be located centrally if apparent at all.

The shrunken form of hypermature cataract presents an anterior chamber of normal or increased depth, a milky white surface showing irregular whitish dots or spots in place of radial or sector markings, and no iris shadow.

The morgagnian cataract presents a homogeneous milky white surface. Frequently the upper edge of the dense nucleus which has sunk to the bottom of the capsular sac is seen as a semicircular dark or brownish shadow in the otherwise whitish pupillary area. The shadow can be seen to move as the position of the nucleus is altered by the movements of the head. When the patient is supine, the pupillary area may become entirely white, for the nucleus will then lie out of view posteriorly—obscured by the liquefied cortex anteriorly. The anterior chamber may or may not be shallow.

With a miotic pupil, the intumescent, mature, and both forms of hypermature cataract may present a similarly whitish pupil —consequently mydriasis is an important aid to arriving at the correct diagnosis.

### Indications for surgery

In general, all mature cataracts that have been permitted to progress to the morgagnian stage of hypermaturity should be extracted if prognostic tests reveal that the neuroretinal system is apparently intact. The presence of a morgagnian cataract in an eye with potential vision is almost without exception an indication for surgery, for the reason that this type of cataract is a danger to the eye itself. An eye containing a morgagnian cataract is constantly exposed to the possible development of the following complications:

1. *Subluxation or luxation of the lens*—the former being much more common. Because of the fragile state of the zonule—particularly in older patients—the lens may become dislocated with almost no provocation. Even a slight subluxation will frequently be manifested by iridodonesis and/or vitreous in the anterior chamber. A completely dislocated (luxated) lens may enter the vitreous or the anterior chamber. Iridocyclitis and glaucoma are almost constant eventual, but not necessarily immediate, sequelae of subluxation and luxation.

From my experience it must be added that the zonule is not invariably fragile in morgagnian cataract. This is particularly true in the younger patient. The most resistant zonule that I have ever encountered in any cataract operation on an adult occurred in a 35-year-old patient with bilateral morgagnian cataracts.

2. *Glaucoma.* Increased intraocular pressure may result from the toxic effect of cortical material seeping through the apparently intact capsule. Mechanical pressure of a dislocated lens may be another etiologic factor, as well as spontaneous rupture of the lens capsule.[2]

3. *Uveitis.* The same factors that produce glaucoma can produce a concomitant or isolated uveitis.

### Prognosis

Inasmuch as the morgagnian cataract completely prevents ophthalmoscopic visualization of the fundus, the following tests are of value in estimating the prognosis for restoration of vision in such a patient:

1. *Light perception.* Absence of light perception is usually an absolute contraindication to cataract surgery. However, see under pupil reaction.

2. *Light projection.* Usually the test light can be accurately located by the patient with morgagnian cataract. However, it should be remembered that inaccurate light projection occurs rarely in these cases, even though subsequent extraction reveals normal visual acuity, fundus, and fields. The explanation

is that this form of cataract so diffuses the test light that point localization becomes impossible.

3. *Red and green lights.* Accurate identification of red and green lights is a favorable finding.

4. *The reaction of the pupil to light.* Clinically it may be stated that the reaction of the pupil to light reflects the functional capacity of the optic nerve. One of my patients with bilateral morgagnian cataracts, who had been blind for four years, not only was unable to locate the test light but absolutely insisted that he could not see the light. However, the pupil reactions both directly and consensually were normal.

The patient did not have the widely dilated fixed pupils that are characteristic of blindness due to optic atrophy. Bilateral intracapsular extractions were performed. Postoperative examination revealed normal visual acuity, normal fundi, and normal fields.

As this case illustrates, subjective tests can be quite unreliable. The pupillary reaction to light is objective in nature and therefore carries added significance as an indication of neuroretinal function.

5. *Light following.* Accurate light following will occasionally contradict the patient's insistence that he cannot see or locate the light.

## Surgical approach

In all cases an attempt should be made to extract the cataract with the capsule intact. Vail[1] has indicated that capsulotomy results in an almost explosive opening of the capsule with extrusion of the lens contents and has been followed by iritis, updrawn pupil, and even loss of the eye.

Although in my small series of extracapsular morgagnian cataract extractions (14 cases), there was no significant difference in the postoperative course as compared with those in which the delivery was intracapsular, it is felt that the intracapsular method is preferable because of its relatively uninvolved nature (no irrigating of the anterior chamber, no searching for a small nucleus), the possible toxicity of the liquefied cortex, and the possibility of "losing" the nucleus when the lens capsule ruptures.

In extracapsular cases, the anterior chamber must be thoroughly irrigated in order to remove all traces of the milky contents that have been released. The small hard nucleus can be embarrassingly elusive and, if left within the eye, will usually result in uveitis and glaucoma.

1. *First phase of the operation.* The volume of literature will attest to the existence of more than one acceptable approach to the first phase of any cataract operation—the opening of the anterior chamber. Therefore only three suggestions are offered:

a. Hyaluronidase is not used in the retrobulbar injection except in those cases with elevated intraocular pressure. An abnormally soft eye is not desirable before the section has been made, for it makes the placing of corneoscleral sutures more difficult and also hampers the production of an accurate section.

Although a softened eye may theoretically—and perhaps actually—decrease the chances for vitreous loss once the section has been made, it also unfortunately decreases the effectiveness of the pressure utilized in delivery of the lens and places greater emphasis on traction.

b. After the section has been completed, the keratome should be withdrawn slowly in an attempt to prevent rapid decompression of the anterior chamber. In one of my cases, rupture of the anterior capsule was apparently caused by too rapid decompression of the chamber which resulted in the bursting of the lens capsule.

c. The preplaced corneoscleral sutures should be properly isolated and identified before the eye has been opened. The surgeon must be prepared to close the wound as soon as possible after the lens has been delivered or after an emergency has arisen.

2. *Second phase of the operation.* Each

case must be evaluated individually in deciding whether a peripheral or complete iridectomy is indicated. If there is no contraindication, the dilatation of the pupil should be determined before surgery. In uncomplicated cases, if the pupil will dilate to six mm. or more, there should be no qualms about attempting a peripheral iridectomy and round-pupil extraction.

3. *Third phase of the operation.* In the actual extraction of the morgagnian cataract, the following procedures should be attempted in the listed order in an endeavor to obtain the highest percentage of intracapsular deliveries:

a. The Smith-Indian operation. Inasmuch as the morgagnian cataract typically possesses a fragile capsule which is tense and difficult to grasp with forceps, a method which employs pressure and no traction is ideally suited. The so-called Smith-Indian operation is just such a method.

In this operation, as carried out by me, pressure and counterpressure are used to initiate tumbling and delivery of the lens. Point pressure is exerted at the limbus inferiorly at the 4-, 6-, and 8-o'clock positions with a Kirby lens expressor, while a lens loop bridges the limbal wound at the 12-o'clock position with the slightest simultaneous counterpressure to discourage a sliding delivery and to produce dislocation of the lens forward inferiorly at the 6-o'clock position.

If this method is to be successful, the equator inferiorly at the 6-o'clock position will appear in the pupil.

The tumbling delivery is then completed by continued cautious pressure with the lens expressor inferiorly and similarly cautious counterpressure with the loop immediately scleral to the posterior lip of the limbal wound at the 12-o'clock position.

Frequently after tumbling, a portion (the original superior equator) will have a tendency to lie within the wound. In such cases, I prefer to draw the sutures partially taut, thus closing the limbal wound somewhat, and then to sweep the cataract from the lips of the wound with the elbow of the lens expressor. Many lenses will rupture at this point if traction is attempted.

It must be emphasized that, if the initial conservative attempt to dislocate the lens inferiorly is not successful or if the lens wishes to come forth as a "slider," no further attempts be made for posterior luxation or vitreous loss may then occur.

b. The micro-erisophake. The erisophake has markedly facilitated the intracapsular extraction of the morgagnian cataract. The surgeon who has failed to subluxate the lens with a conservative attempt with the Smith-Indian method or the surgeon who is reluctant to employ that method should then utilize the micro-erisophake (I use the Bell type).

The technique may be outlined:

The erisophake is filled with saline and the suction cup is then inserted into the anterior chamber from the 10-o'clock direction and is slid under the iris in the 5-o'clock meridian.

When the whole perimeter of the cup is in contact with the lens capsule peripherally, the rubber bulb is squeezed between the thumb and index finger, thus expressing the saline. Pressure is slowly released from the bulb, creating a vacuum which results in the cup's grasping the lens capsule.

The Kirby lens expressor held in the left hand is then applied with moderate pressure just on the corneal side of the limbus alternately at the 4-, 6-, and 8-o'clock positions. Minimum traction—directive traction—is maintained by tilting the erisophake upward in the corresponding meridian as point pressure is applied with the expressor.

Once the zonule has been peeled from a portion of the inferior equator of the lens, the lens will be seen to subluxate forward inferiorly. The surgeon must watch for this subluxation carefully for it marks the moment when further pressure with continued minimum "directive traction" just sufficient to promote tumbling is to be carried out.

After the lens has been tumbled, it should be slowly expressed upward and through the wound by combined pressure and minimum traction.

c. The lens loop. Although Chance[3] recommended the lens loop extraction of the morgagnian cataract as standard procedure, this method is advocated only in cases of subluxation and luxation.

Occasionally, as soon as the keratome section has been made, the anterior chamber will fill with vitreous and the lens will be found subluxated. In other cases in which too vigorous pressure has been applied in the Smith-Indian operation, the lens may be subluxated or even luxated posteriorly into the vitreous.

In such cases the lens loop should be introduced behind the lens. The lens is pushed up against the cornea. Then with a Kirby lens expressor pressed against the outer surface of the cornea, the lens is made to glide well onto the loop and is then withdrawn, pressure being made against the cornea with the expressor until the lens has been removed.

This same method is applicable to both anteriorly and posteriorly luxated lenses—the latter being much more formidable.

In the case of the morgagnian cataract that lies in the anterior chamber the initial entrance into the chamber should be made with the von Graefe knife as described by Alexander and Kennedy of the Cleveland Clinic[4] or by the so-called scratch method with a Bard-Parker knife or keratome. The pupil should be constricted with eserine and the loop should be introduced behind the lens with extreme care in order not to enter the vitreous chamber through the hidden pupil.

In my series, there was one case of anterior luxation. In this case all that remained of the original morgagnian cataract was a small brown nucleus. The cornea was clear and the intraocular pressure was not elevated—evidence that anterior luxation does not necessarily produce glaucoma.[4]

After the pupil had been constricted with eserine, the anterior chamber was entered by means of a scratch incision. As the incision was being extended with Steven's scissors the wound buckled and the nucleus was extruded intact—like a pea from a pod—leaving a black pupil. There was no evidence of capsule either in the anterior chamber or around the nucleus. Because the limbal wound was small, it was decided to close the wound with the previously placed corneoscleral suture without performing an iridectomy. The postoperative course was uncomplicated.

d. Procedure when the capsule ruptures. Rupture of the anterior capsule will result in immediate flooding of the anterior chamber with milky white liquefied cortex. In such cases the nucleus should be expressed carefully onto a lens loop and withdrawn from the eye. The anterior chamber should then be irrigated thoroughly until all evidence of cortical material has been flushed from the chamber.

It is to be emphasized that the nucleus must be removed from the eye even at the expense of vitreous loss, for a retained nucleus almost always means an ultimate uveitis and/or glaucoma for that eye.

4. *Fourth phase of the operation.* After the lens has been extracted, the corneoscleral sutures should be drawn taut immediately to close the wound. Toilet of the wound is then carried out in the manner preferred by the surgeon.

*76 South Fitzhugh Street.*

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# NOTES, CASES, INSTRUMENTS

## NEW LIGHT-WEIGHT GLOVES*

R. M. Fasanella, M.D.
*New Haven, Connecticut*

Gloves in a sense may be considered an important eye instrument although some eye surgeons still debate whether they should be used. Just before a cataract extraction one day, Dr. William Glenn, chief of cardiovascular surgery, Yale University School of Medicine, suggested that I try a new light-weight pair of gloves. These gloves had been designed for him for palpating inside the human heart. He had given them a successful trial over a period of five months.

In exploring the inside of the human heart, especially in mitral stenosis and intraventricular defects, he had found that the ordinary white surgeon's gloves and even the brown-milled surgeon's gloves were too thick to permit the degree of finger sensitivity required. In animal hearts he used bare fingers for this touch but here, too, although the needed sensitivity was present, he found that the friction of the finger over the areas of the heart being explored was an undesirable quality preventing ease of motion. To meet the needed qualities of sensitivity, friction resistance, and total asepsis, Dr. Glenn had had the new light-weight surgeon's brown-milled glove made.

The SR 832 Seamless Crest surgeon's glove is brown-milled and has approximately the same tensile and elongation quality as the ordinary surgeon's brown-milled glove. It is 47-percent thinner (average gauge SR 832: 0.0045 to 0.005 to 0.010 for the ordinary brown); 47-percent lighter

$$\frac{\text{1 doz. SR 832 size 7½}}{\text{5.38 oz.}}$$

to

$$\frac{\text{1 doz. ordinary brown size 7½;}}{\text{11.38 oz.}}$$

47-percent softer:

$$\frac{\text{SR 832}}{\text{3 oz.}} \text{ to } \frac{\text{ordinary brown}}{\text{6 oz.}}$$

The new glove is made from pure gum rubber from the up-river Para section of Brazil. Ordinary gloves are usually started from liquid rubber. This new glove is produced by multiple dips—a lamination of pure gum rubber. It has added strength at the wrists. Being made of the same basic compound as the usual surgeon's soft brown-milled glove, it has the added quality of being hypo-allergenic.

Although Dr. Glenn has found the wearing quality and asepsis equal to that of ordinary gloves, he personally feels that they should be reserved for strictly delicate surgery.

In using these new light-weight gloves for cataract extraction, I was immediately impressed by their softness. There was less finger fatigue (due to less constriction) and a high degree of finger sensitivity. These new gloves are thinner, lighter, and softer. The tensile and aseptic qualities are not decreased. Since they have been used clinically for only five months their actual wearing qualities are still to be determined.† Their property of friction resistance may not be needed in most cases of delicate eye surgery. My use of these new light-weight gloves makes me consider them a valuable aid in all eye surgery but especially in intraocular surgery.

*789 Howard Avenue (4).*

*From the Section of Ophthalmology, Yale University School of Medicine. The product described is the SR 832 Seamless Crest surgeon's glove manufactured by the Seamless Rubber Company, New Haven 3, Connecticut.

†The gloves have been used for intraocular surgery for six months now and, even though their wearing quality seems half that of other gloves, I shall continue to use them. The manufacturers will add another dip to the new gloves.

## BLANK FOR SKETCHING LESIONS OF THE FUNDUS*

CONRAD BERENS, M.D.
*New York*

Because the blanks for sketching the fundus previously described by my father† are no longer available, a new blank with slight changes from the original has been developed.

These blanks, which are 15-cm. square and approximately 10 times the diameter of the normal fundus, have been found to be of great value in facilitating the recording of fundus changes (fig. 1). By inverting the charts, they may be used for drawing the right or left fundus. It has been deemed wise to represent the disc as vertically oval, and it measures 11 by 15 mm. The vessels have been omitted because of the great variation in their distribution, size, and diameter, even in normal eyes. An excellent grade of glazed paper has been selected for impressing the print of the orange-colored stippled fundus outline.

In using the plates, the arteries are drawn with a red pencil and the veins with a blue pencil. Although the paper may be adequately marked with crayon, colored pencils, ink, or an ordinary lead pencil, the ideal medium for more intense, exact, and permanent recording is the use of opaque water colors which are obtained in tubes or jars. Fine white lines may be made with the point of a pin, knife, or razor blade, and wider lines or patches of atrophy made with the flat surface of a knife, or the orange surface may be shaded lighter with an eraser. Enlargement or change in the shape of the disc is accomplished by erasing a part of the colored surface surrounding the white disc outline or by shading in with an orange pencil.

A composite fundus (fig. 2) illustrates the various mediums used:

The arteries were drawn with a red crayon and the veins with a black instead of blue crayon, because blue reproduces poorly. The nasal artery which shows compression, is highlighted with the use of a pin.

The macular star and the smaller patches of atrophy were made with the point of a penknife, and the larger patch beneath the star was made with the flat surface of a razor blade.

An opaque water color and ordinary black pencil were used for drawing the pigmented patch of chorioretinitis in the upper field. Edema and congestion of the temporal margin of the optic nerve were drawn with a red pencil and white water color for highlights and the poorly defined nasal margin was depicted by the use of an orange water color. Hemorrhages were represented with a medium and darker shade of red pencil.

The extent of a retinal detachment may be drawn in rapidly with a white pencil. The size and shape of a retinal tear may be emphasized with a dark-orange pencil, as shown in the lower temporal quadrant of Figure 2, between the 4:30-o'clock and 6-o'clock positions. Opaque white water color may be used, blended with light gray water color, to give a more realistic appearance of a detachment with folds, as shown between the 4:30-o'clock and 5-o'clock positions in Figure 2.

Artistic ability is not necessary to draw the paths of the arteries and veins or to spot in pathologic alterations, which can be accomplished quickly with any of the mediums mentioned.

*708 Park Avenue (21).*

* The blanks are made by the American Optical Co., Southbridge, Massachusetts. This study was aided by a grant from the Ophthalmological Foundation, Inc., and the Department of Research of the New York Association for the Blind. From the Department of Ophthalmology, New York University.

† Berens, C., Sr.: Blanks for sketching the fundus oculi. Wills Eye Hosp. Rep. 1:68 (Jan.) 1895.

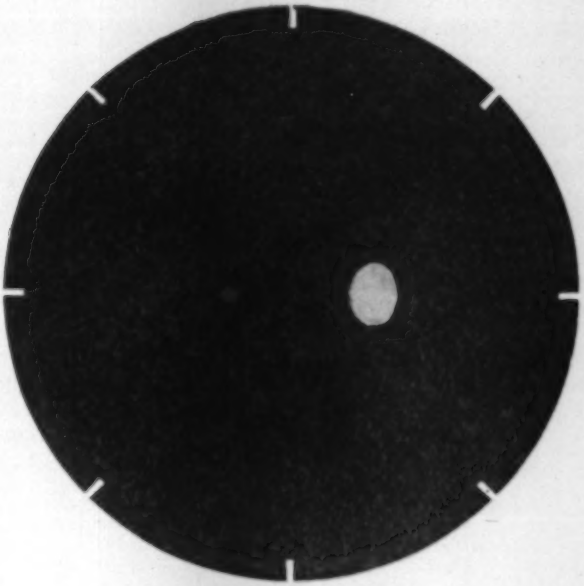

Fig. 1

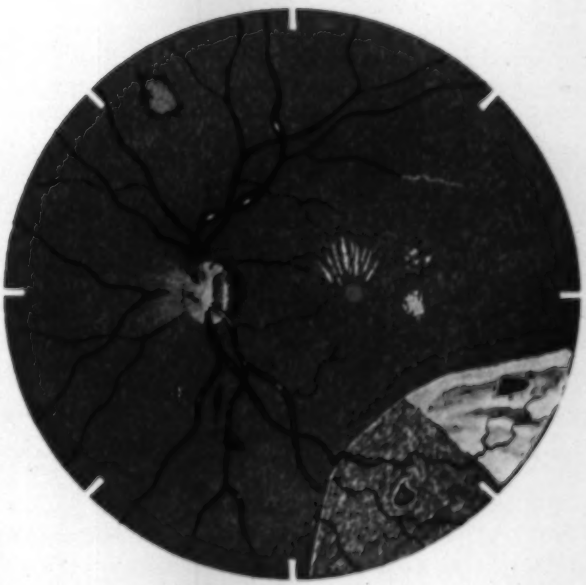

Fig. 2

Figs. 1 and 2 (Berens). Blank for sketching lesions of the fundus.

(Fig. 1). Fundus chart which may be reversed for the right or left eye.

(Fig. 2). Composite sketch showing retinal detachment with tear, using a white pencil (lighter area) and opaque white water color. Arteries and hemorrhages drawn with red pencil; macular star, neighboring white patches, and copper-wire appearance done with pin and penknife point. Pigmented patch depicted with yellow opaque water color and ordinary lead pencil.

## ADAPTER FOR TANGENT SCREEN PROJECTOR*

WILLIAM H. HAVENER, M.D.
AND
JACK H. PRINCE, F.B.O.A. (ENG.); F.R.M.S. (ENG.)
*Columbus, Ohio*

The B & L tangent-screen projector, with self-contained grid, should be mounted eight feet seven inches from the tangent screen in order to produce the proper size grid. If the available room is of inadequate size, the projected grid is too small.

Correction of this may be made by a Galilean telescopic system clip-mounted in front of the projector. The Galilean telescope consists of a plus objective and a minus ocular which are separated by the difference between their focal lengths. Its magnification equals the ratio between the dioptric strengths of the two lenses (for example, a + 2.0D. and a − 4.0D. lens mounted 25 cm. apart give X2 magnification). The telescope is reversed (minus lens in front) to enlarge the projected grid.

* From the Department of Ophthalmology, University Hospital.

Determination of the percent increase in size required is done by measuring the distance between 0 and 25 degrees as projected. As can be determined from tangent tables, 25 degrees at one meter should be 47 cm. If the grid projects 25 degrees as 38 cm., as ours did, then it is nine cm. too short and requires 9/38 or approximately 25 percent magnification. This is produced by −10D. and + 8.0D. lenses, mounted 2.5 cm. apart, with the minus lens in front. Some alterations in this theoretic distance apart are necessary in practice.

The lenses were mounted in a 38-mm. inside diameter tube, and held in place by sliding internal rings. The outside surface was painted black, and the tube was mounted on the projector by means of metal clips.

Intensity of illumination should be standard, since loss due to magnification is offset by the reduced distance to the screen.

### SUMMARY

Use of the tangent screen projector in a small field room is made possible by a properly calculated Galilean telescope mounted in reverse on the projector.

*University Hospital.*

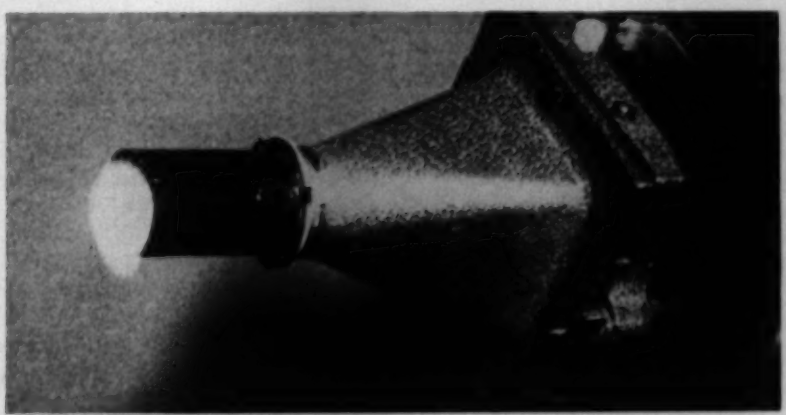

Fig. 1 (Havener and Prince). Adapter for tangent-screen projector.

## PERFORATED PROSTHESIS

WILLIAM BROWN DOHERTY, M.D.
*New York*

After the fitting of an artificial eye, it has been my observation that in many cases the prosthesis seemed to float, as it were, in a lake or reservoir of fluid, limiting its motility and producing a pseudoexophthalmos. This has been demonstrated upon the removal of the artificial eye by a gush of tears.

The idea occurred to me that, if perforations were made in the lower part of the artificial eye where they would be hidden in the lower cul-de-sac, drainage would be established and the prosthesis would fit more closely to the underlying conjunctiva.

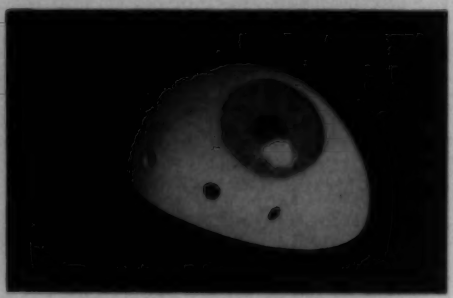

Fig. 1 (Doherty). The perforated prosthesis.

I am enclosing a photograph of such an eye which was made for me by Mr. Hugh W. Laubheimer of Mager and Gougelman, Inc., New York. The patient's motility and tearing seemed to improve. The prosthesis was more comfortable.

*150 West 55th Street.*

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## MANAGEMENT OF CONVERGENCE INSUFFICIENCY AND DIPLOPIA

### IN A PATIENT WITH INTRACRANIAL ANEURYSM

WILLIAM T. BROWN, M.D.
*New York*

The problem of intracranial aneurysm is not a simple one. Most investigators agree that a defect of the media against persistent pressure, whether from congenital (residual weakness at site of the primitive trigeminal vessels) or acquired causes, plays a dominant part in its formation. Congenital intracranial aneurysms are more frequently unilateral.

About half of all cerebral aneurysms affect the internal carotid artery after piercing the dura mater, or they may occur in the cavernous sinus. Clinical manifestations are due to the presence, trauma, location, pressure, or rupture of the aneurysm.

General ocular symptoms and signs include vague headaches on the side of the lesion, gradual or sudden impairment of vision mostly on the same side. Field defects, which vary, include central scotoma, nasal hemianopsia, amaurosis on the same side with a temporal defect of the other eye. If the crossed nasal fibers of the other retina are under pressure, or if the chiasm is pushed against the contralateral sclerotic carotid or the bony structure, an added nasal defect on the contralateral eye may result in blindness of the eye opposite to the side of lesion.

Binasal hemianopsia is rare; however, it is conceivable that the carotid aneurysm, exercising direct pressure on the uncrossed fibers of the same side, may cause indirect pressure on the uncrossed nerve fibers on the contralateral side by pushing the chiasm to the opposite bony structure or against the contralateral sclerotic carotid.

The aneurysm frequently involves the trigeminal ganglion, causing Raeder's paratrigeminal syndrome of pain along the fifth-nerve, relative insensitivity of the homolateral cornea, and third-nerve palsies. Optic atrophy, with or without pathologic cupping, may occur. Frequently it is more pronounced on the side of the lesion. If the aneurysm ruptures into the subarachnoidal space, it is often fatal. If single or multiple ruptures occur into the brain substance, symptoms and signs of increased intracranial pressure may follow. Emotional excitement, alcohol, hypertension, or large pulse pressure may thin or stretch the aneurysm, causing low

grade or intermittent leakage, before rupture, with meningeal symptoms.

Anatomically there are usually three kinds of carotid aneurysm: saccular, berry-form, and diffuse fusiform dilatations.

## Case report

*History.* H. B., a 38-year-old man, a clerical worker, was referred for ophthalmologic consultation in November, 1953. He gave the history of a fall on his head in 1943, while in military training. He was unconscious for a few seconds only. On recovery, he had no symptoms; however, some months later he began to have hazy vision in front of his right eye and difficulty in co-ordinating and focusing with his right eye. Later he was found to have high blood pressure, which necessitated his discharge from military service. In July, 1952, he suffered an attack of subarachnoid hemorrhage and an intracranial aneurysm was diagnosed. He survived and had only vague symptoms of ill-defined headaches, mostly on the right side.

In March, 1953, he was hospitalized and a right carotid angiogram revealed a small aneurysm arising in the intracranial part of the right internal carotid artery in its supraclinoid portion. A left carotid angiogram (done because of the possibility of multiple aneurysms) revealed no evidence of a left-sided lesion. His case and therapy were discussed in a joint neurologic-neurosurgical conference. As a result, a gradual cervical ligation of the internal carotid artery was decided upon. It was felt that an intracranial ligation of the carotid above the aneurysm was too risky, partly because of close vicinity of the posterior communicating artery and the high mortality in intracranial ligation procedures.

An hour and a half after the artery has been completely ligated in the neck, the patient had a transient left hemiplegia, which disappeared in a few minutes before the ligation could be undone. He recovered uneventfully.

On Christmas Day he was involved in an automobile accident, at which time he was thrown forward, striking his head. His main complaint after this was an inability to focus with his right eye and diplopia worse at near vision. He had to cover his right eye when reading or writing to avoid diplopia and confusion. He also complained of a transient monocular diplopia with either eye.

*Subsequent eye examination* revealed no gross external abnormalities.

*Visual acuity* was: R.E., 20/40+; L.E., 20/30+; O.U., 20/20. He was wearing: R.E., + 1.0D. sph. ⌒ − 1.0D. cyl. ax. 180°; L.E., + 0.87D. sph. ⌒ − 0.87D. cyl ax. 15°. He had better visual acuity for distance without glasses.

Motility studies revealed a convergence insufficiency and diplopia setting in, without correction

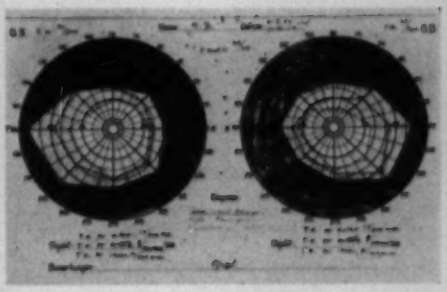

Fig. 1 (Brown). Quantitative fields.

at 55 cm. measured from the root of the nose. With his correction, diplopia occurred at 40 cm.; 6$^{\Delta}$, base-in in front of right eye eliminated the diplopia. These readings indicate his average measurements, which varied somewhat on different occasions.

Ductions with either eye, did not reveal any abnormality. There were no pupillary changes. Intraocular pressure measured: O.U., 26.5 mm. Hg (Schiøtz).

*Fundus examination* under paredrine (one percent) mydriasis revealed: R.E., clear media, well-defined disc but considerably hyperemic with dilated capillaries and veins, increased epivascular reflexes, few crossing phenomena including segmentation, serpentine pulsation, no exudates, no hemorrhages; L.E., hyperemic disc. R.E. > L.E., unusual looping of vessels at disc and vicinity. Increased epivascular reflexes-increased venous and arterial pulsation R.E. > L.E., few deflection phenomena, no exudates, no hemorrhages.

*Quantitative fields* were as shown in Figure 1.

It is interesting to note, that no monocular diplopia was elicited in either eye with the red glass, while the other eye was covered.

The patient, as a clerk with a desk job, was most annoyed by the diplopia and convergence insufficiency, which he could only control by covering his right eye, preferring to use his left eye only for near vision. He was in constant fear of losing his job.

With the head erect, without glasses, his diplopia started at 55 cm. from the root of the nose, 45 degrees downward from the horizontal level. His glasses corrected about 15 cm., as his diplopia started at 40 cm. with glasses.

*Prescription.* He was given: O.U., 1$^{\Delta}$, base-in, clipovers to wear with his glasses for close work. This corrected his diplopia to 25 cm., which allowed him fusion without difficulty at ordinary near distance of 30 or 40 cm.

He likes his clipovers. He can use both eyes now while working, which has also considerably allayed his fears in connection with his job.

*333 Central Park West (25).*

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## TAPERED IMPLANT

### For insertion along floor of orbit

Wendell L. Hughes, M.D.
*Hempstead, New York*

This implant* of methyl methacrylate with a tantalum mesh on its lower convex surface is designed for use along the floor of the orbit for raising the contents of the orbit. It is made in three thicknesses at the anterior part to gain more or less elevation of the soft tissues of the orbit.

The tapered end is placed in a prepared pocket toward the apex of the orbit, along the floor of the orbit if possible, with the convex surface, to which the tantalum is applied, being placed downward and the smooth, slightly concave surface up toward the soft tissues.

This form is designed to eliminate the necessity of using cartilage or bone for this purpose. It is useful in cases of depressed fracture with or without the eye present.

* Made by the Monoplex Division of the American Optical Company, Southbridge, Massachusetts.

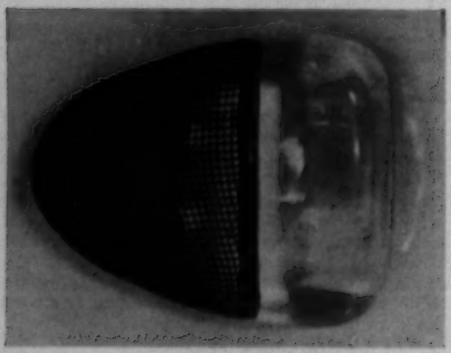

Fig. 1 (Hughes). Bottom view of implant, showing tantalum mesh applied to the posterior two thirds of the lower surface.

Fig. 2 (Hughes). View from the front, showing the convex lower and concave upper surfaces.

The eye can be raised in this manner when depressed and in cases in which the eye is absent and the upper lid is sunken even without a fracture, the hollow in the upper lid can be filled out by the use of this orbital implant. It serves to increase the volume of the orbital contents and elevate them, so that the eye (or the artificial eye) is held up to support the upper lid in a natural manner.

The original skin incision is arcuate and made either a little above or below the displaced lower orbital margin. The incision is then made down to the orbital margin and carried along the orbital floor.

The form must be placed well back and the tarso-orbital fascia securely closed anteriorly with the skin incision being closed separately. In patients wearing an artificial eye, the lower fornix must be carefully preserved and re-anchored with sutures down toward the orbital margin to preserve its integrity. Two or three double-armed sutures passed through the fornix and brought out through the skin below suffice for this purpose.

The tantalum mesh serves as a framework for integration with the tissues to prevent extrusion forward.

*131 Fulton Avenue.*

# SOCIETY PROCEEDINGS

Edited by Donald J. Lyle, M.D.

## YALE UNIVERSITY CLINICAL CONFERENCES

Dr. R. M. Fasanella, *presiding*

February 26, 1954

### Evaluation of plastic procedures

Introducing the subject, Dr. Arthur Gerald DeVoe, New York, emphasized the limitations of plastic surgery, and recommended a careful and realistic evaluation of the possible final result before embarking on prolonged therapy or multiple operations. Several slides were shown of cases in which a worse deformity resulted, demonstrating what should not be done. Especially to be considered is a situation in which an immobile lid will be the end result. Here an ordinary patch over the defect may well be less conspicuous than the end-result.

Three fundamental principles in treatment were stressed:

1. The concept of two-layer closure in lid repair. Skin and muscle comprise one layer, tarsus and conjunctiva the other. Two ways to utilize this principal were demonstrated—the halving procedures and the tongue-and-groove method. If the lid is unusually thin, the latter method would be better.

2. The use of incisions and repairs which follow the lines of the normal lid folds as much as possible.

3. The use of subcutaneous sutures to take up the tension in closure, with skin sutures just to coapt the edges.

*Discussion.* Dr. R. M. Fasanella: What is your opinion about the usefulness of peritoneum in repairs, and does it match well the bulbar conjunctiva?

Dr. DeVoe: I have no personal experience yet, but am about to try it. Mouth mucous membrane does not match well, and tends to shrink down.

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March 12, 1954

### Embryologic defects of eye

Leon S. Stone, Ph.D., Bronson professor of comparative anatomy, Yale University School of Medicine, discussed the factors which determine the development of various eye structures. Many of the determining factors were demonstrated by Dr. Stone's ingenious animal experiments. Four developmental stages were discussed:

1. In the earliest stages, it is demonstrable experimentally that the eye centers are induced in the anterior neural plate by agents in the underlying mesoderm. Narrowing the underlying mesoderm by removing lateral strips will cause the developing eyes to be progressively closer together until true cyclopia is produced when the central mesoderm strip has been sufficiently narrowed.

2. Later in development, it can be demonstrated that the optic vesicle and early optic cup have agents for inducing (a) lens, (b) ocular muscles, (c) eyelids, (d) other surrounding structures. If the optic cup is removed before it touches the surface ectoderm, no lens will develop. Further, belly ectoderm can be transplanted to the area over the optic cup, and will develop into a lens. This will occur also if the transplanted surface ectoderm comes from another species, or even from a parthenogenetic individual with one-half the normal number of chromosomes. Lens formation can be prevented by implanting mesoderm between the surface ectoderm and optic vesicle so they do not touch each other. A relation can be shown between the size of the eye and the size of the lens. If lens be transplanted from a species that characteristically grows a large eye into an individual with a characteristically small eye, the developing large lens will cause the eye to grow larger.

3. In the optic-cup stage, the following

are important: (a) The future functional retinal fields are polarized. Rotating the eyeball will result, after the central nerve connections are later established, in a reversed retinal field. (b) Lens-cup contact influences lens-fiber formation. (c) The ocular muscles and lids are induced and polarized at this time. If the eye is removed early, no muscles or lids develop. The eye organizes the surrounding structures. (d) The vitreous body begins late in the optic cup stage. (e) In mammals, the hyaloid artery begins to play a role at this time.

In summary, Dr. Stone emphasized that much of the future of the eye and surrounding tissues is determined at a very early stage, and that toxins affecting the fetus at an early stage could presumably produce almost any defect.

*Discussion.* Dr. Clarke brought out the clinical problem of the size of the orbit when enucleation is done early in life, or in extreme microphthalmos. He described some attempts to use a distensible implant, but faulty prosthetic material at that time gave inconclusive results. He asked Dr. Stone whether living tissue was necessary for proper development of orbit size, or whether he thought pressure of a suitable distensible implant would be enough.

Dr. Stone was unable to answer this question from his present experimental results.

Those who had seen the clinical cases agreed in the diagnosis of the cases presented. Dr. Clarke felt that repeated X-ray studies on bony orbital size, initially showing no difference in size, would show a difference if repeated at a later age. Dr. Fasanella pointed out the weighty psychological and cosmetic problems presented by microphthalmos, especially in girls. Dr. Francis P. Guida made the suggestion that lenses for magnification only would serve as a partial solution.

### Microphthalmos

Dr. R. M. Fasanella, presented M. S. who was first seen on May 20, 1953, at which time she was four months of age. The child was born full-term in a normal spontaneous delivery. There were no complications or illnesses of the mother during the pregnancy, no febrile episodes, no childhood diseases, no German measles.

The referring physician and the mother felt that the child could not see well out of one eye.

Examination showed a microphthalmos of the left eye. The right eye seemed normal in every respect, measuring approximately 10 mm. in the vertical and 11 mm. in the transverse diameter. The left eye, however, measured approximately nine mm. in each diameter. Intraocular pressure seemed normal in each eye. At the time of the initial examination, the dilated pupil showed a congenital foldlike mass.

X-ray studies (May 26, 1953) of the skull read: "Views of the skull both in Towne projection and lateral projection, as well as special views of the orbits and optic foramina, show the bony structures surrounding the orbits to be of equal size bilaterally, and normal throughout. The optic foramina are well visualized and are of normal size. No abnormal intracranial calcifications of the skull, nor any abnormality of any of the bones making up the bony calvarium could be noted. X-ray diagnosis: Indeterminate skull."

This child is now 14 months old and may follow light with the left eye. The measurements are about the same. Direct light reflex: O.D. and O.S., (?) consensual from right to left; ? from left to right. The right fundus seems normal; the left, incompletely dilated, shows a slight red reflex above and nasally and a retrolental mass in the rest of the fundus.

Dr. R. M. Fasanella said that on January 6, 1954, the patient, A. M. S., a three-weeks-old white girl was referred to him. The baby was born full-term, normal spontaneous delivery, with a red right eye and a small left eye with ptosis. The baby is now four months old. The mother remembered no serious illness during pregnancy. The

mother's mother died during the first month of this pregnancy. The mother had had a cold two weeks prior to delivery but no German measles during pregnancy.

The patient was placed on eye drops and ointment and the conjunctivitis in the right eye subsided. The important problem, however, was the microphthalmos of the left eye.

The right cornea measured 11 mm. in transverse diameter and about 10 mm. in the vertical. The cornea was clear with no evidence of glaucoma. The fundus picture could not be made out in detail because of the age of the patient, but it seemed that the retina on this side was normal.

The left eye measured in the transverse diameter only about six mm. The whole external eye, including the palpebral fissures, was small. Surprisingly, the cornea was clear, the pupil round, and the media seemed clear. In the area corresponding to the left optic disc there was a large white disc, all the borders of which could not be made out. But there was a suggestion of a coloboma. Both pupils reacted to light.

In summary, there was a conjunctivitis in the right eye which responded to medication and a microphthalmos of the left eye. X-ray studies of the orbit for size were not made. The baby is now three months old, and the findings are essentially unchanged.

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## March 26, 1954

### The eye in symbol and symptom

Dr. Henry H. Hart, said that the eye is more than a sense organ which can become diseased, but has come through thousands of years of evolution to have a symbolic meaning indispensable to the understanding of certain symptoms. From the intellectual standpoint it is man's most precious organ, because through it reality is more comprehensively perceived. Optical stimulation produces a change in electroencephalographic rhythm more readily than auditory stimulation. When we take into consideration that the eye is, embryologically, derived from the brain, the only part of the nervous system exposed to the outer world, we can appreciate its more direct intellectual significance.

Social relations are made possible through the eye. Schilder notes that imitative movements seem to be due to the fact that the visual presentation of the movements of another person is apt to evoke the representation of a similar movement in our own body. In the expression of another's eye we find his meaning and we tend to see ourselves with the eyes of others.

The most important emotional states with which we are concerned are fear (or anxiety) and guilt, differentiated psychologically but not physiologically. Whenever the act of looking becomes associated with horror at the things seen or guilt over pleasure in looking, the organ involved becomes incapacitated by the unconscious mechanism of punishment. In both World Wars, hysterical blindness frequently followed the shock of a terrible spectacle threatening to the ego. This was often associated with amnesia for the traumatic event. Constriction of the fields of vision and blepharospasm are similarly caused. Envy, jealousy, and hate also find their part in ocular disorders.

It is important to bear in mind that seeing is a very pleasing process in all ages, and particularly in childhood. Even the infant can be distracted from pain by an interesting object visually perceived. Scopophilia is the term referring to pleasure in looking. Since, in our culture, sexual objects are particularly taboo, guilt becomes associated with the forbidden pleasure of peeping. French photographs illustrate well enough the aphrodisiac pleasure and guilt connected with the seeing of nude bodies in sexual embrace. Wherever guilt is aroused, punishment mechanisms are resorted to, to reduce the effects which are more painful than physical pain. The eye is not only the organ involved in the guilty act but is the organ that betrays the guilt.

St. Lucy of Syracuse, patron saint of eye

diseases, had such lovely eyes that she captivated a young man, but had such fear that her chastity would be lost that she plucked out her beautiful eyes and sent them to the young man on a salver. "If thine eye offend thee," said St. Matthew, "pluck it out and cast it from thee." From prehistoric times the eye was punished for various offences connected with seeing and sex. Sometimes blepharospasm as a symptom much more clearly symbolizes the desire to shut out the forbidden spectacle.

Repression, evasion, and displacement in ocular symptoms do not choose for their expression specific portions of the ocular mechanism. Thus the same retreat from the world of reality can be expressed in myopia, restriction of the visual field, and blepharospasm.

The profound emotional significance of the eye is emphasized in the study of compensatory psychologic reactions of the blind or the near blind. Denial of blindness is such a very common trait as not at all to be surprising. Denial of all defects is part of our narcissistic defense system. There is nothing we hate to display to others so much as our defects and weaknesses. The loss of the eye, like the loss of parent or mate, is unbearable to the ego and is therefore often denied altogether. Few blind people give up the hope that something may be discovered that will restore their sight. The Bible and the newspaper tell of miraculous recoveries of eyesight.

It is important in our treatment of the blind that we develop whatever compensation the individual can produce which is socially useful. The achievements of the blind in the history of science and literature require but brief mention. Milton wrote his *Paradise Lost* when blind and defeated, politically and economically. Prescott, despite the injury to his left eye at Harvard and the loss of his right eye shortly after graduation, spent the rest of his life in a darkened room devoting himself to literary research and developed a phenomenal memory to aid in his monumental works. It is noteworthy that Galileo's last telescopic discovery of the moon's diurnal and monthly libration was made only a few months before his eyes were closed in hopeless blindness. Milton, himself destined to become blind, found Galileo in this condition in 1638. The vision of both these men was, in the religious and political sense, prohibited by the arbitrary power of both church and state. They saw what was taboo.

It is probable that in connection with the widespread superstition of the "Evil Eye" we can see most clearly the significance of the eye as an organ of aggression. Of all forms of superstition this one is the oldest and widest. No science, religion, or law has been able to eradicate it.

Dr. Hart then cited many actual cases of psychiatric problems associated with the eye. He concluded:

The material here presented offers an opportunity for reflection upon the psychosomatic problem of why displacement of punishment is directed to the eye instead of some other part of the body. Is the intensity of guilt over scopophilia a sufficient explanation for this? It has been my experience with eye patients that the resistance to any penetration of light into the cause of their guilt is unusually great. The eye is not only the organ punished for seeing the forbidden but it symbolizes the rejection of insight.

"I wish to remain blind to any further enlightenment," seems to be what they say.

The patients with glaucoma that I have studied and about whom I wish to make a subsequent report give the impression that a part of their life is to be blotted out forever and they resent the psychiatrist bringing it up to light again, even when their intraocular pressures seem to be relieved by the process.

"I shall never look at this part of my life again," is the unconscious message.

Though the loss of eyesight has been painful, something has been blotted out which seems to have been more painful.

*Discussion.* Dr. David Freeman: I saw in consultation the son of a professor who had a myopia for the blackboards in one subject only. This was mathematics. He could see the board well for all other subjects. Careful inquiry showed that the father had also always done poorly in mathematics.

Dr. Eugene Blake commented on Santa Lucia as guardian saint of vision. He had written a paper on the role of Santa Lucia.

Dr. I. K. deSuto-Nagy commented on the relationship of attacks of acute congestive glaucoma and the emotional factors often precipitating these attacks. She asked how one could prove exactly what part emotional factors played in chronic simple glaucoma.

Dr. Hart replied that he did not know the answer to this but felt that the psychiatrist could certainly serve as a safety valve in preventing some attacks of acute congestive glaucoma. He cited work on 16 psychiatric cases seen with Dr. Willis Knighton. He discussed in some detail the careful case study of a middle-aged, unmarried woman who was closely attached to her family. Her glaucoma was well controlled but would rise during periods of stress in the family, turmoil, or with guilt feelings. One specific incident was that of an affair of her unmarried sister with a married man. Release from her family stabilized this patient and also stabilized her glaucoma.

William I. Glass,
*Secretary.*

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## NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

April 5, 1954

Dr. Bernard Fread, *President*

### Problem of divergence excess

Dr. Edwin Billet presented a paper on this subject during the instruction period.

### Double innervation of oculorotary muscles

Dr. Arthur Linksz said that the motor apparatus of the eyes is, as Burian so aptly stressed, "entirely in the service of the sensory apparatus." One can distinguish an oculokinetic and an oculostatic function in it. The first, the phylogenetically younger function, keeps the image of the object of attention on the foveas and brings it back in case it shifts. It needs a fovea to work. The second, the phylogenetically older function, maintains the orientation of the eyes toward the panorama. It is older than the fovea. The two functions are governed by spatially separated oculorotary reflex arcs. So far it has been assumed that this separation of pathways is maintained only on the supranuclear level and that both the occipital (essentially oculokinetic) and the frontal and vestibular (essentially oculostatic) impulses feed into common final effector channels, with intercalated, so-called supranuclear centers doing some necessary rearrangement. In this lecture, an alternate hypothesis is being offered, according to which separate reflex arcs retain their individuality up to the effector organs, thus providing for double innervation of each and every extraocular muscle. This eliminates the necessity of subcortical rearrangement centers and allows envisaging the motor innervation to the extraocular muscles in accordance with the plan which prevails all over the rest of the body.

### Raubitschek test

Dr. Joseph I. Pascal said the Raubitschek arrow, first presented about 25 years ago, consists of two parabolic arcs converging at one end to form the tip of an arrow and diverging at the other end to form the base of an arrow. These two lines comprise all possible directions of an astigmatic dial in infinitely small gradations. The most sensitive part of the arrow is at the tip, where axis discrepancies of one degree may be noted. A similar sensitivity exists here for the cylinder power.

The difficulty in applying the test has been the rather cumbersome procedure of having to use a set of tables, or two revolving disks with two different scales. In the new redesigned procedure, a single revolving disk is used with a single scale. The procedure involves the use of two angles which the examiner applies during the test for finding the amount of astigmatism after locating the axis. The examiner can repeat the test, using different angles in the same case. This gives him an unparalleled opportunity for making multiple tests in difficult cases.

The outstanding features of the test are:

1. The patient at all times has to compare only two adjacent lines.

2. At the critical stage, either for locating the axis or finding the amount, there is a shift of a black streak or shadow from one wing of the arrow to the other. This jump of the streak is a striking phenomenon appreciated even by less intelligent observers. In addition the patient can be shown a set of three small charts before the examination which illustrate the phenomenon of the shifting shadow which he will see on the large dial.

### Experiences with alternating esotropia*

Dr. Abraham Schlossman and Dr. Julius M. Shier summarized the characteristics of alternating esotropia. In 32 percent of the cases, the patients apparently began to squint in the first year of life; 21 percent in the second year; and 47 percent had their onset after the second year. Only 12.9 percent were "true alternators"; 4.6 percent preferred one eye for distance and the other for near, while the remainder of patients demonstrated the ability to alternate fixation even though they have preferences for one eye or the other.

In the medical treatment of alternating esotropia, the importance of the atropine refraction and the wearing of the full correction for at least four months prior to surgery was stressed.

The pros and cons of bilateral recessions versus recession and resection were discussed. Since both types of operations gave the same number of good cosmetic results, the greater flexibility of the recession-and-resection operations, especially if further surgery was necessary, led the authors to recommend these procedures in preference to bilateral recessions.

*Discussion.* Dr. Kestenbaum said that Dr. Schlossman had put his finger on the main problem of strabismus operations. In different patients, resections of the same amount may give completely different results. This generally confirmed observation may be explained as follows:

After a resection, say of the lateral rectus, this muscle has a stronger effect than it had before; at the same time its antagonist, the medial rectus, is overextended and, according to a general rule, an overextended muscle has an increased effect. Therefore the total effect of the resection of the lateral rectus is not a simple "strengthening" of this muscle; it equals the difference in "strengthening" between the operated muscle and its antagonist. Since the increase in effect of the individual muscle depends also on its previous thickness and strength, the end effect of the operation is unpredictable. A six-mm. resection may result in a four-mm. rotation of the eyeball in one case and in a one-mm. rotation in the next case.

Similarly, a recession of a muscle results not only in a "weakening" of this muscle but also in a diminished tension and therefore a diminished effect of the antagonist. Again the total effect equals the difference in "weakening" of the two muscles and is therefore unpredictable.

In order to get an exact predictable result, the state of the muscles has to remain unchanged; neither of them should have a higher or lower tension after the operation than before. This may be achieved by a com-

* This paper was published in full in The Journal, 39:351-358 (Mar.) 1955.

bination of resection of a muscle with a recession of its antagonist, just to the same extent. Such a combination actually means a simple rotation of the eyeball, without a change in tension of either muscle.

The relation between the known degree of strabismus measured in prism diopters and the extent of the required surgical rotation of the eye measured in mm., is a simple one. Since the rotation is measured in mm. on the scleral surface which is about 12.5 mm. distant from the center of rotation and the prism diopters are measured in cm. at one m. distance, one mm. rotation corresponds with eight prism diopters.

An esotropia of, let us say, 50 prism diopters therefore requires a six-mm. (50 divided by 8) resection of the lateral rectus and a six-mm. recession of the medial rectus. If this is actually done it must result in a correction of 48 prism diopters. In high degrees of strabismus, of course, surgery may be done on both eyes, for example, three-mm. resection and three-mm. recession on each eye.

Dr. Levitt then asked what were the results of orthoptic treatment.

Dr. Billet emphasized Dr. Schlossman's remarks about using several atropine refractions before surgery; he thought it was a very important point.

Dr. Kronenberg commented that some of the differences in the results obtained by recession operations are due to differences in the operating technique. For instance, many men do not cut the posterior check ligaments; their results are different from those who do. Furthermore, this type of paper presents a problem because it is not the study of one man's work, using one technique, but that of many men using different techniques. It is, therefore, very difficult to draw any definite conclusions from this type of paper.

Dr. Schlossman replied that, in regard to orthoptic training, those patients who have a relative orthophoria for distance and a great deal of strabismus for near do quite well with orthoptic training; however, this is a small group. In replying to Dr. Kronenberg he said that, when a paper was based on the work of many men, especially the surgical work of many men, it had certain advantages and certain disadvantages. Certain mistakes were brought out and these could be avoided in the future, while the good techniques could be followed.

Bernard Kronenberg,
*Recording Secretary.*

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## CHICAGO OPHTHALMOLOGICAL SOCIETY

March 15, 1954

Dr. Gail R. Soper, *President*

The Suker Memorial Clinic was presented at Cook County Hospital.

### Scientific program

### Pathway for darkness and reflex pupillary dilation.

Dr. Alex Arieff: While pursuing defects in autonomic regulation in patients with quadriplegia, it was found that there is evidence in the literature that pupillary dilation to pain is by way of parasympathetic inhibition instead of sympathetic excitation. This is true in such animals as the cat but has never been proved in man. In monkeys, Bender and Weinstein found that painful stimulation, as in the ciliospinal reflex, causes pupillary dilation by way of the sympathetic pathways.

Nineteen patients with complete lesions of the cervical spinal cord were studied. Faradic (painful) stimulation was done above and below the level of the lesion and the pupillary reaction was observed. It was found that, in complete cervical-cord lesions, painful Faradic stimulation above the lesion fails to cause pupillary dilation (loss of descending impulses by way of injured cervical

spinal cord), while stimulation below the lesion on the chest wall results in pupillary dilation as well as other sympathetic symptoms (by way of thoracic sympathetic outflow). Therefore in man pupillary dilation due to pain is sympathetic stimulation.

Dilation of the pupil to darkness was found in man with complete cervical-cord lesions. Therefore, this is not due to sympathetic stimulation by way of the ciliospinal center, since suprasegmental impulses cannot descend through the cervical spinal cord. This reaction is probably due to a reversal of the light reflex or parasympathetic inhibition by known pathways.

None of these reactions can be explained on hypersensitive denervation, since the parasympathetic and sympathetic pathways were intact in these patients with cervical spinal cord lesions.

*Discussion.* Dr. Julia Apter said that these experiments corroborate the hypothesis of pupillomotor activity recently advanced by Ury and Gellhorn, Langworthy and Ortega, Harris, Hodes, and Magoun. Their hypothesis states that pupillodilation to proper physiologic stimuli is mediated solely by inhibition of the parasympathetic innervation of the constrictor muscle superimposed on constant tonic impulses supplied by the sympathetic innervation of the so-called dilator muscle. This allows dilation when parasympathetic activity is low and prevents excessive miosis when parasympathetic activity is maximal.

Since 1904, when Langley and Anderson observed pupillary dilation following electric stimulation of the superior cervical sympathetic ganglion, authoritative opinion has adhered to the theory that all pupillodilation was mediated by action of the sympathetic innervation of the iris. The preservation of pupillodilation to darkness and divergence following section of these fibers, as in Horner's syndrome, was attributed to action of sympathetic fibers outside the cervical sympathetic tract.

From Dr. Arieff's experiments, however, it would seem that high cervical section of the cord results in the same picture of pupillomotor activity as in Horner's syndrome; preservation of all responses except the ciliospinal reflex. It may be deduced, therefore, that the only reflex transmitted by sympathetic fibers in man is the ciliospinal reflex; all other pupillodilation is mediated by inhibition of parasympathetic activity.

This one preserved reflex is a very small increase in the size of the pupil which cannot be elicited in bright light. Both consensual darkness dilation and divergence dilation can be elicited in bright light. It follows, therefore, that the ciliospinal reflex is not a true opposition to the constrictor action of the parasympathetic fibers; it is merely an increase in sympathetic tone. The only true opposition to constrictor action is provided by inhibition of parasympathetic activity.

Richard C. Gamble,
*Recording Secretary.*

# AMERICAN JOURNAL OF OPHTHALMOLOGY

*Published Monthly by the Ophthalmic Publishing Company*



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## AMERICA'S FIRST NATIONAL PROGRAM IN EYE RESEARCH

Your editor-in-chief, Dr. Derrick Vail, has asked me to write an editorial on the program in eye research at the National Institute of Neurological Diseases and Blindness.

This honor comes at a propitious time, for it coincides with the appointment of Dr. Ludwig von Sallmann, who will come to the Institute this August for the purpose of directing the Institute's intramural program in eye research at Bethesda. More about Dr. von Sallmann later; first, however, permit me to sketch the organization, objectives, and outlook for the future of the National In-

stitute of Neurological Diseases and Blindness.

The creation and development of the National Institute of Neurological Diseases and Blindness, I believe, came about as a product of a changing environment in medical research, which developed during and after World War II. During this period of increasing national income, the American public became more and more aware of the meaning of science to health and, as a consequence, more persistent in its pursuit of additional financial support from all sources, both private and governmental, for the activation of programs dedicated to the conquest of disease.

It is not surprising, therefore, to find that the country's medical research expenditures rose from 45 million dollars in 1940 to 173 million dollars in 1953,[1] an increase of about 300 percent. Evidence now in hand indicates that these figures are climbing even higher.

In this growing research environment the largest portion of government support for medical research has been centered in the National Institutes of Health, the principal research activity of the Public Health Service in the Department of Health, Education, and Welfare. Here, as in the case of private support of research, there has been considerable budgetary expansion. For example, the 1923 budget for the National Institutes of Health (then known as the Hygienic Laboratory of the Public Health Service) was about $400,000; while the 1953 budget was 71 million dollars, or roughly 150 times larger.

Concomitant with the increasing support for medical research was a definite shift of research emphasis from acute to chronic disease. The discovery and dramatization of antibiotics, modern advances in preventive medicine, and the increased life expectancy of the average American seem to have reduced the fear of death from acute infectious diseases and placed a sharper focus on the rising menace of chronic disease. The first groups of chronic disease to arouse the public interest were the "killers," cancer and heart disease, and then the "cripplers," mental disorders, arthritis, neurologic disorders, and blinding diseases.

It was on this background of mounting public interest and the shifting emphasis in medical research from acute to chronic diseases that the National Institute of Health really began to expand into its present structure of distinct research institutes, each one bound to a categorical group of diseases. The National Cancer Institute was founded in 1937, followed by the National Heart Institute in 1948. Shortly thereafter, a further trend to the chronic aspects of disease or, at least, to long-term disabilities which carry a greater economic burden in their wake, resulted in the establishment of the National Institute of Arthritis and Metabolic Diseases and the National Institute of Neurological Diseases and Blindness, both in 1950.

## Early cradling

The National Institute of Neurological Diseases and Blindness, the youngest of the National Institutes of Health, was established in August, 1950, by Public Law 692.[2] The bill authorizing the establishment of the Institute actually represents a merger of at least five different bills petitioned for by voluntary health agencies to create an institute for various neurologic disorders and for blindness. Since the establishment of several institutes for closely related neurologic disorders presented an intractable administrative problem, the various petitioners finally agreed to unite in a single institute, which would embrace all neurologic disorders and blindness.

At this point I might digress to pose a question which at times has been asked:

"Why was blindness coupled with neurologic disorders, or, conversely, why were not blindness and neurologic disorders established as separate institutes, each with its own director"?

The answer to this question lies partly in administration and partly in methodology.

When the Institute was established, funds and physical facilities at the National Institutes of Health were insufficient to administer and house two separate institutes. This is still true today. Moreover, in a strictly scientific climate where research and not treatment is the ultimate mission, the line of demarcation between ophthalmology and neurology, often so sharply drawn in clinical practice, tends to evanesce. Experimental ophthalmology and experimental neurology are merely different points on the same assembly line, which, to be explored completely, must be explored collaboratively.

Derrick Vail[3] has emphasized the close relationship of ophthalmology to neurology in a research setting, while Macdonald Critchley[4] has done the same from the standpoint of the research neurologist in his presidential address, delivered before the Section on Neurology of the Royal Society of Medicine in London.

Now returning to the nascent period of the Neurology and Blindness Institute, we find that its birth, though perhaps overdue, was untimely from a fiscal standpoint. It was created two months after the onset of the Korean War when the nation began to tighten the purse strings of domestic programs to meet the needs of national defense. As a result, no appropriation was made available to the Institute in 1950, and it was not activated even on a planning basis until 1951. Even in 1952 the Institute still functioned on a "stand-by" basis.

But in 1953 the seriousness of neurologic disorders and blindness as a public health problem began to be acknowledged; the Institute's appropriation was increased by 225 percent. Again in 1954, the 1953 figure was almost doubled and its program was definitely "off the ground"; its research productivity was surging at a remarkable rate.

Many ophthalmologists rallied to the support of the Institute during its early struggle for life and an opportunity to produce. Among them were Dan Gordon, Derrick Vail, Jonas S. Friedenwald, Lorand V. Johnson, Alan C. Woods, and David G. Cogan. Also supporting the program were many voluntary and welfare agencies for the blind, notably, the American Foundation for the Blind, the National Society for the Prevention of Blindness, the National Council to Combat Blindness, and the National Foundation for Eye Research.

### Research responsibilities

The Institute's reponsibilities, as set forth in Public Law *692*, are to search for better means of diagnosis, prevention, and treatment of neurologic and blinding disorders. To this end, of course, we must necessarily focus our attention most sharply on those chronic disabilities which affect the largest number of people over the longest period of time. In eye research, therefore, of greatest concern to us are cataract, glaucoma, uveitis, diabetic retinopathy, retrolental fibroplasia, and other chronic blinding disabilities resulting from disease and injury.

In order to discharge these responsibilities, the Institute also is authorized to award grants for research projects and the training of scientific personnel to nonfederal institutions and universities. It also conducts both fundamental and clinical investigations in neurologic and blinding disorders with the facilities available for this purpose at the National Institutes of Health. Therefore, the Institute's total activities are made up of two parts; first, an extramural portion, or grants program in research and training, and second, an intramural program in laboratory and clinical research, conducted, in the main, in the new Clinical Center at Bethesda.

### Research grants program

The largest portion of the Institute's activities concern the extramural, or grants programs, especially research projects related to neurologic and ophthalmic disorders. At present the Institute supports 80 projects in eye research in 21 states. The increase in grant awards for research projects made by

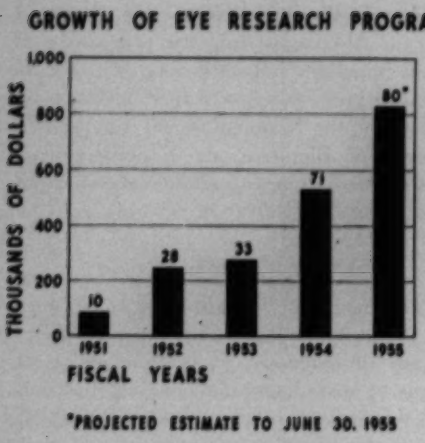


FIG. 1

the Institute is depicted in Figure 1; the increase from 1951 to 1954 being about 124 percent.

Applications received for grants to support research projects are given critical review by an appropriate panel of experts, or study sections, as they are called. These study sections, of which there are 19, are not staffed from the Institute, but are composed of experts in a particular scientific field, who are appointed from nongovernment institutions. For example, the Sensory Diseases Study Section, which relates most closely to projects in ophthalmology, is under the chairmanship of Phillips Thygeson.* If no appropriate study section exists for a particular project, it is referred to a carefully selected ad hoc committee.

The recommendations of the study sections and ad hoc committees then are forwarded to the Institute's National Advisory Council, which is the supreme advisory board to the Institute and the Surgeon General of the Public Health Service in all matters pertaining to neurologic and blinding disorders. The membership of the Council includes ophthalmologists, neurologists, biological and physical scientists, deans of medical colleges, and prominent public-spirited citizens noted for their leadership in health enterprises. The ophthalmologist now on the Council is Jonas S. Friedenwald; his predecessor was Derrick Vail.

The council examines the recommendations made by the study sections and ad hoc committees on all research grant applications. The final recommendations of the Council are then forwarded to the Surgeon General for action. The usual lapse of time between receipt of the original application and notification of the action taken by the Council and Surgeon General is about three months.

The extramural activities of the Institute and its National Advisory Council, however, are not limited to the consideration of research grant applications. Not infrequently, they participate in the organization and support of broad co-operative projects which require the collaboration of many investigators and institutions. An example of such a co-operative study is the recent one in which 75 ophthalmologists and pediatricians united in 18 different hospitals to investigate the etiologic significance to retrolental fibroplasia of curtailed oxygen administration to premature infants.[8] Also associated in support of this co-operative study was the National Society for the Prevention of Blindness and the National Foundation for Eye Research.

### TRAINING GRANTS PROGRAM

Correlative with the growth in eye research is the need for specialized training to develop an adequate supply of scientific manpower. It is generally recognized that research and training are mutually interdependent if a growth of knowledge is to be sustained. For, unless the laboratory scientist can rely on a pool of young scientists-in-training, his program will not survive for long. Similarly, if there is not a productive source of young clinical investigators-in-training, important laboratory discoveries

* Other members of this Study Section are Bernard Becker, Norton Canfield, Frederick Crescitelli, Hallowell Davis, Peter Kronfeld, Irving Leopold, and T. C. Ruch.

may remain concealed for years before they can be tested in the clinic.

The Institute's program for the graduate training of clinical teachers and investigators in ophthalmology is designed to alleviate the present paucity of clinical scientists in this field. Here, I should point out that the primary purpose of our training program is not to enhance the present supply of practicing ophthalmologists, but rather to develop more clinical researchers and teachers who wish to pursue an academic career in ophthalmology.

Funds for a modest graduate training program were first supplied to the Institute in 1953. Consequently, this program has not yet reached the maturity of our program in research projects. Today, the Institute has awarded training grants in ophthalmology to eight medical schools and two hospitals. Training grant applications in ophthalmology are reviewed by a special Training Grants Committee under the chairmanship of David G. Cogan* and then are forwarded to the National Advisory Council for its final recommendations to the Surgeon General.

A valuable adjunct to the Institute's training grants is a program for the award of fellowship and clinical traineeship stipends to promising young scientists and clinicians. The Institute currently supports 30 fellows and 45 trainees.

### Intramural research program

Probably most of you have heard of the Institute's intramural research program which is conducted at Bethesda. The underlying purpose of this program, as in the case of all the Institutes at the National Institutes of Health, is to strengthen lines of communication and cross-fertilization between clinical and laboratory research. The medical and laboratory sciences have grown indispensable to each other; but each has become so internally specialized that effective communication between the two has become inordinately difficult. The intramural program at Bethesda presents a plan to solve this problem on a research level by bringing the clinical and laboratory scientist directly together, face to face.

Accordingly, the Institute's intramural program is composed of a laboratory branch, staffed by many of the country's leading investigators in the sciences basic to ophthalmology and neurology; and of a clinical investigations branch in ophthalmology and neurology. While laboratory branches and the clinical investigation branches operate autonomously, they function in close liaison, or as teams in their research activities.

The clinical investigations in ophthalmology bring to mind again Dr. Ludwig von Sallmann, to whom I promised to return on the first page of this editorial. For it is this program that Dr. von Sallmann will come to direct in August. Here he will continue his work in ocular physiology and pharmacology and will organize and expand the department to its full potential. Dr. von Sallmann is recruiting scientific personnel now; six positions have been filled and it is hoped that another 10 positions can be filled in the near future. A nursing unit of 26 beds and 26 laboratories are currently assigned to clinical investigations in ophthalmic disorders.

Dr. von Sallmann will not have to seed his program in untilled soil. For over a year, a competent but young staff of ophthalmologists, under the direction of Dr. Ralph W. Ryan, has been functioning at the Institute. This limited staff already has managed to initiate promising studies in granulomatous uveitis, cataract, and glaucoma.

### Future outlook

So far I have limited myself to a brief commentary on the origin, philosophy, and major activities in the growth of the National Institute of Neurological Diseases and Blindness, which, I believe, represents America's first national program in eye re-

* Other members of the Training Grants Committee are Alson E. Braley, Irving Leopold, and A. Edward Maumenee.

search. It is customary to terminate such a program commentary with a few speculations about prospects for the future.

The future prospects for this national program in eye research, of course, depend on many factors. Excluding the influence of changing national trends in medical research, which to me are upredictable, I consider that the prospects for the immediate future are rather bright. The decision of Dr. von Sallmann to come to the Institute makes them look even brighter.

However, the long-term future for a program of this scope cannot depend solely on a few individuals. Whether or not the program can rise to its full potential strength and so maintain itself depends chiefly on the interest, support, and participation in its activities by the people of this country, particularly those who have a specific stake in the future of eye research. The sufferers of those disorders, which is our responsibility to attack and conquer, have a definite stake in the program's future; so do the voluntary and welfare agencies for the blind, or the prevention of blindness; so do the laboratory and clinical scientists who seek new opportunities and techniques in eye research. And, finally, so do the teachers of ophthalmology and the practicing ophthalmologists, for the ultimate objectives of the Institute are to provide them with more effective tools and materials for the diagnosis and treatment of ophthalmic disorders.

Pearce Bailey.*


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* Director, National Institute of Neurological Diseases and Blindness, National Institutes of Health, Public Health Service, U. S. Department of Health, Education, and Welfare.

## DEDICATION OF ARMED FORCES INSTITUTE OF PATHOLOGY

The dedication of the new home of the Armed Forces Institute of Pathology by President Dwight D. Eisenhower at 1:30 p.m. Thursday, May 26, 1955, formally opened a new era in the remarkable history of this unique organization. Founded during the Civil War by The Surgeon General, W. A. Hammond, a leader fully cognizant of the importance of research and training to the conquest of disease, this institution was destined to become nationally and internationally famous as the Army Medical Museum. From 1862 until the 1920's major emphasis was on the museum and teaching activities. Then, under the wise leadership of Major (now Brigadier General, retired) George R. Callender, steps were taken to organize the first of a now-imposing list of Registries of Pathology.

American Ophthalmology is rightfully proud of the part it has played in the organization and development of the American Registry of Pathology, one of the main departments in the Armed Forces Institute of Pathology. Through the foresight and enthusiasm of Callender and representatives of American Ophthalmology, the Registry of Ophthalmic Pathology, the first of the 22 special registries was founded in 1922. For many years this Registry served primarily as a central laboratory for diagnosis and cataloging of ocular lesions. Few other laboratories throughout the country were willing or able to tackle the highly specialized field of ocular pathology. Specimens poured in from civilian as well as military contribu-

tors all over the world but mainly from the United States. Contributions to the Registry of Ophthalmic Pathology now number well over 41,000 accessions and include examples of virtually every disease known to affect the eye.

With the accumulation of this wealth of material at the Armed Forces Institute of Pathology, investigators and students have beaten a steady path to Washington. The many scientific publications based heavily upon Registry material are a matter of medical history, and the remarkable collection of illustrative material has been used fully by many authors of textbooks. In the words of President Eisenhower, "Here is one of those typical partnership efforts that bring government, science, and industry all together to do a great job for the betterment of humanity."

The new era opened by the dedication of this modern research building is one in which there will be a gradual de-emphasis of routine ocular histopathology to permit expansion in experimental pathology. This will be possible without compromising diagnostic service to clinical ophthalmology since, in recent years, many excellent ophthalmologic pathology laboratories have been established throughout the country. On the other hand, the Registry will not die off, but, in fact, become stronger as a result of this changing emphasis. Eye pathology laboratories throughout the country are asked to continue contributing cases of research or teaching value to the Registry so that they may be made available to qualified research workers.

John H. King, Jr.

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## THE SECTION ON OPHTHALMIC RESEARCH

"Ophthalmic Research" is a section of THE AMERICAN JOURNAL OF OPHTHALMOLOGY, to appear in the near future. It will be devoted to the publication of information of primary interest to the ophthalmologist engaged in research, both clinical and fundamental. Abstracts of papers presented at various sectional meetings and at the annual meeting of the Association for Research in

Ophthalmology will be published here. Additionally, abstracts of papers presented at the Federated Meetings as appearing in *Federation Proceedings*, will be included together with similar abstracts from the scientific (not clinical) papers presented at the Wills Eye Conference, the Massachusetts Eye and Ear Conference, and the Wilmer Conference. Abstracts of papers including similar material, will be published but once.

News items concerning grants, traineeships, research support, and the like will also be included in the new section on Ophthalmic Research. This material will originate largely from the National Institutes of Health, the National Society to Combat Blindness, and the National Society for the Prevention of Blindness. Other groups interested in promulgating their support of ophthalmic research are urged to submit material for publication.

Much of the success of "Ophthalmic Research" depends primarily upon the Section Secretaries of the Association of Research in Ophthalmology. It will be their function to send to the Editor of the Section, the abstracts of papers presented at each annual meeting. These abstracts should be definitive and in sufficient detail so that the reader will know the nature of the study and the results. They should be patterned generally after the abstracts appearing in *Federation Proceedings*. No abstract should be longer than one double-spaced, typewritten page with a minimum of one and one-half inch margin on the left-hand side of the page. Generally, bibliographic references should be unnecessary.

To assure prompt publication, the section secretary responsible must insist upon the abstracts being submitted before the conclusion of the meeting. They should be immediately forwarded to the section editor at that time. It is believed that this will allow publication of the abstract within a four-month period.

Frank W. Newell,
Editor of the Section
on Ophthalmic Research.

## SPRING MEETINGS, 1955

The 91st annual meeting of the American Ophthalmological Society was held at the Greenbrier, White Sulphur Springs, West Virginia, on June 2nd, 3rd, and 4th, under the presidency of Everett L. Goar. The surroundings and the weather were equally beautiful and comfortable. The attendance was most satisfactory and the program of high caliber.

Nineteen papers on a variety of ophthalmic subjects were presented and excellently discussed. It is always difficult and invidious to others to pick out the best papers, but it is proper to mention and spotlight the unusual number of those that dealt with general medical subjects with ophthalmic connection. These were:

"The importance of ophthalmoscopic photographs in forensic medicine," by A. J. Bedell; "Total and permanent blindness following administration of hexamethonium chloride," by G. M. Bruce; "Periorbital fibrous dysplasia," by R. O. Rychener, et al.; "Glial tumors of the retina in relation to tuberous sclerosis," by J. M. McLean; "Myopia caused by prematurity," by H. L. Birge; "Progressive nuclear ophthalmoplegia," illustrated by a most striking motion picture, by W. J. Holmes; "Tumors of the lacrimal gland," by T. E. Sanders, et. al., and "Corneoscleral lesions in periarteritis nodosa and Wegener's granulomatosis," by D. G. Cogan. The other papers dealt with subjects of strictly ophthalmic interest.

The felicitous social activities, receptions, cocktail parties, sports, and informal table discussions as usual contributed to the peaceful and happy atmosphere of good fellowship and "shop" talk.

The following officers for 1956 were elected: President, Alan C. Woods; vice-president, Frederick C. Cordes; secretary, Maynard C. Wheeler; and Gordon Bruce continues, we are all glad to say, his able work as editor of the *Transactions*. Wilfred E. Fry was appointed to the council, the chairman of which for 1956 is Georgiana D. Theobald.

The Howe Medal was bestowed on Arthur J. Bedell, most justly awarded for his many valuable contributions and many years of devoted and distinguished service to American ophthalmology. The next meeting of the society will be held at the Homestead, Hot Springs, Virginia.

The 104th annual meeting of the American Medical Association was held in Atlantic City June 6th to 10th. The Section on Ophthalmology and the Association for Research in Ophthalmology held a combined session. The scientific programs of each of the organizations were exceptionally good and we finished the strenuous three days with admiration for the exceedingly high quality of the scientific work being done in ophthalmology in this country. Since the programs have already been published in THE JOURNAL, some in abstract form, there is no need here to detail the work presented.

The address of the chairman of the section, Erling W. Hansen, had for its subject "Credo" and consisted of noble statements of high ideals. Dr. Hansen conducted a difficult and arduous session with composure and great ability. J. W. Tudor-Thomas of Cardiff, Wales, and James H. Doggart of London, England, were the Invited Foreign Guests of the A.M.A., and the Section on Ophthalmology. Mr. Tudor-Thomas spoke on the "Fixation of corneal grafts," and, since he is a pioneer authority on the subject of keratoplasty, his address was followed with absorbing interest. Mr. Doggart chose as his subject, "Impact of boxing upon the visual apparatus." His address was most witty, erudite, and entertaining. It consisted of a blast, like an atom bomb, against the "manly" art of self-defense. Boxing is "a sacrilege and not a sport," said Doggart, who went on to describe the serious injury to the head, eyes, and brains of those who indulge in this exercise. The release of the contents of his address to the newspapers was widely used, we hope with benefit to the public at large and to the boxing profession specifically.

Twenty-three papers comprised the program of the section. This number, larger by half a dozen or so than usual, and the lack of time, necessitated the chairman severely to restrict the time allotted to each presentation, and the discussion, with rare exceptions, only to those who were officially designated. It seemed to many of us that this was most undesirable, although, unfortunately, necessary, for discussion from the floor is always a most valuable part of the event. Even so those many who attended, and they filled the large hall, were richly rewarded.

The officers for 1956 who were elected are: Chairman, A. D. Ruedemann, Sr., of Detroit, Michigan; vice-chairman, John B. Hitz of Milwaukee, Wisconsin.

The Knapp Medal of the Section for 1953 was awarded to David G. Cogan of Boston for his paper, "Ocular dysmetria." The Distinguished Service Medal of the Section was bestowed by Francis H. Adler, the chairman of the executive committee, on Frank B. Walsh of Baltimore, for his valuable contributions to the field of neuro-ophthalmology. That the choice of the recipient was a most popular one was attested to by the loud and prolonged applause of the standing audience.

The section displayed eight excellent scientific exhibits. Of these, the exhibit, "A new concept of the development of the angle of the anterior chamber of the human eye," by H. M. Burian, A. E. Braley, and Lee Allen of Iowa City, received the Certificate of Merit. Honorable mention was awarded to the exhibit of L. E. Zimmerman, J. H. Bickerton, and H. C. Wilder Foerster of the Armed Forces Institute of Pathology on "Specific clinicopathologic types of granulomatous inflammation." It is also gratifying to note that, among the exhibits of the Section on Military Medicine, the one on "Chorioretinal lesions due to thermal radiation from atomic bombs," by David V. L. Brown and H. W. Rose of the USAF School of Aviation Medicine received a Certificate of Merit.

The executive committee announced that prizes of $250 for the best paper, and $250 for the best scientific exhibit at each session

were to be awarded annually. This measure was heartily approved by the members of the section. The sums are to be supplied by the Knapp Fund of the section.

A special business meeting of the section was held in the evening of June 7th. The hall was crowded and the audience stayed until the end—adjourning sometime after midnight. A number of important resolutions regarding the optometry and dispensing problems were presented, thoroughly discussed, for the most part approved, and forwarded to the House of Delegates of the A.M.A. in time to be accepted by that body, it is understood. These resolutions will be the subject of a subsequent editorial when officially they appear in print in the *Journal* of the A.M.A. It is sufficient here to note that the section overwhelmingly voted in favor of those that were approved. The position of American ophthalmologists is now very clear, unequivocal, and strong regarding these two subjects.

The meetings of the Association for Research in Ophthalmology occupied the afternoons of June 7th, 8th, and 9th, beginning almost at once after the conclusion of the morning meetings of the section. In spite of this eight (or 10) hour day of continuous sitting, a large, interested audience attended and the discussions were good and lively. Twenty-eight papers were presented, many of them extraordinarily good, and sometimes as exciting as a drama or story unfolded. About a third of the contributions had immediate clinical applications; the others were of a purely experimental nature. One of the highlights was the "Symposium on recent trends in Diamox research," V. Everett Kinsey, moderator. The participants advanced considerably our knowledge of just how Diamox works in inhibiting the formation of aqueous.

At the banquet of the association, the Proctor Medal was awarded to Prof. George Wald of the Harvard Biological Laboratory, Cambridge, Massachusetts, whose many superb scientific contributions to ophthalmology have enhanced so much of our knowledge of the physiology of vision, especially. Prof. Wald received the Eli Lilly prize from the American Chemical Society in 1939, and the Lasker Award of the Public Health Association in 1953. He is professor of biology at Harvard University, and has been a very active member of the association for a number of years.

William B. Clark of New Orleans is the chairman for 1956. The next meeting, combined with the section, will be held during the annual convention of the A.M.A., in Chicago from June 11 to 15, 1956.

The association has shown an extraordinary and increasing vigor since 1930 when it was established (membership, 134) to the present (membership, 713 or more). The quality of its program has steadily improved, especially in the last decade. The remarkable growth of research in ophthalmology in the last few years in this country is a most exciting development, and we have considerable reason to believe that this progress in experimental ophthalmology will continue its rapid pace in the future. The association has had an important part in this growth and its influence is widespread.

Those of us who had the privilege and opportunity of attending these spring meetings return home with renewed energy and determination to do a good job. Our knowledge is increased and our pride in our science enhanced. At the same time, we are somewhat depressed because the "art is long and life is short."

Derrick Vail.

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## OBITUARIES

### ARTHUR FERGUSON MacCALLAN (1872-1955)

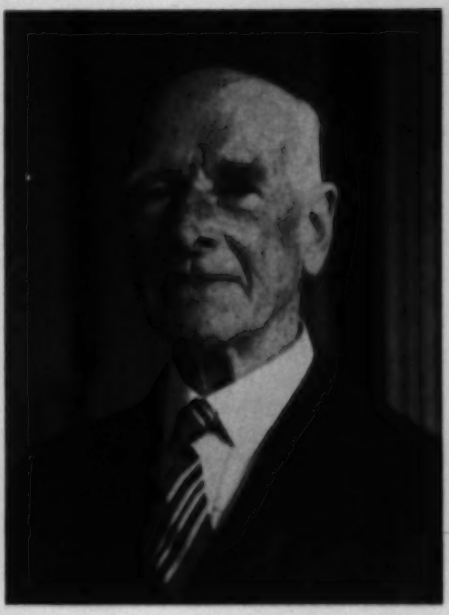
As founder and director of the Ophthalmic Hospitals of Egypt, and as president of the International Organization Against Trachoma for many years, Arthur Ferguson MacCallan was known throughout the world

for his invaluable contributions to the battle against trachoma and the acute ophthalmias which have for so long been the scourge of the Middle East and Orient. He was born in 1872, the son of the Rev. J. Ferguson MacCallan, Vicar of New Basford, Notts, and was educated at Charterhouse and Christ's College, Cambridge. He completed his medical studies at St. Mary's Hospital, qualified in 1898, and took the F.R.C.S. in 1899. His ophthalmic training was obtained at the Royal London Ophthalmic Hospital where he was house surgeon and then chief clinical assistant.

In 1903, MacCallan was invited to organize the newly constituted Egyptian Ophthalmological Service under the trust established by Sir Ernest Castle for the purpose of combatting trachoma and the acute ophthalmias that so plagued Egypt. He accepted the appointment and immediately undertook an exhausitive study of trachoma. He became particularly interested in the then poorly understood initial stages of the disease, as seen in children in the government primary schools. In the course of these investigations he formulated his four-stage classification of trachoma which has since become the international standard. His studies were summed up in his Cambridge thesis for the degree of Doctor of Medicine, for which he was awarded the Darwin prize of his college, and in 1913 this valuable report was published with modifications as a monograph entitled, "Trachoma and its complications in Egypt."

One of MacCallan's greatest contributions to Egypt was his training of a corps of young ophthalmic surgeons from among the Egyptian physicians in the Department of Public Health. These he used to man a chain of provincial ophthalmic hospitals, developed first as ambulatory eye hospitals which demonstrated the need for more premanent installations. In remote parts of Egypt he still maintained ambulatory units to carry treatment to patients unable to travel to the more permanent units.

The success of his ophthalmic work was such that in 1912, by order of Lord Kitchener, then High Commissioner of Egypt, MacCallan was induced to undertake a survey of the incidence of ankylostomiasis and bilharziasis in Egypt. For this purpose he organized two traveling hospitals similar to the earlier ambulatory ophthalmic hospitals. The favorable results of this work led in 1913 to his appointment, against his wishes, as head of the epidemiologic section of the Department of Health.



ARTHUR FERGUSON MACCALLAN

When the First World War broke out, MacCallan was on leave in England. He returned at once to Egypt and in 1915 reorganized five ophthalmic hospitals in North Egypt to receive casualties from the Gallipoli campaign. Three of his traveling ophthalmic hospitals were reorganized and sent to Ismailia and Suez to receive Turkish wounded. In 1916 he became senior medical officer with the rank of Major in the Royal Army Medical Corps at the Army base of Mersa Matruh on the Mediterranean Coast of the Western Desert Province. In 1917

he returned to civil ophthalmic work in Egypt and reorganized the ophthalmic hospitals. In 1923 the Egyptian government appointed him Director-General of the Epidemic Services and General Hospitals. In the same year, however, he resigned and returned to London where he was appointed ophthalmic surgeon to Westminister Hospital and surgeon to the Royal Eye Hospital.

MacCallan's enthusiastic interest in Egypt persisted, however, and through his influence the Memorial Ophthalmic Laboratory at Giza near Cairo was erected in 1925 in memory of the men of the Egyptian Labor Corps and Camel Transport Corps who had fallen in the World War. This laboratory, financed by gifts from MacCallan's personal friends and other sources, has had a profound influence on our knowledge of infectious diseases of the eye, particularly through the efforts of Dr. Rowland P. Wilson, its first director. The laboratory now contains a bust of MacCallan by Doyle Jones; it was donated by his former pupils and unveiled by the British High Commissioner in 1931. Recognition of his great work in Egypt is reflected in the many honors accorded him there, including membership in the Egyptian Order of the Nile. Those who attended the International Congress in Cairo in 1937, or who have attended any of the annual congresses of the Egyptian Ophthalmological Society, could not but be impressed by the extraordinary influence of MacCallan in Egypt and by the respect and affection accorded him by the corps of devoted Egyptian ophthalmologists he trained.

On his return to London at the age of 53 years, MacCallan became an active member of the staff of the Westminster Hospital and enjoyed 13 years of ophthalmic practice. When he retired in 1937 he was appointed consulting ophthalmic surgeon, but during World War II he returned for more active duty. Throughout his London years he maintained an intense interest in the problems of trachoma, compiling a new text on the disease and contributing a number of articles on trachoma and the ophthalmias, particularly to the *Revue Internationale du Trachome*. He attended the International Congress of Ophthalmology at Montreal in 1954 and was honored there with the title, "Honorary President of the International Organization Against Trachoma" for life.

MacCallan was an outstanding personality and will be remembered with affection by his many friends and associates in London and throughout the world, but especially by the many Egyptian ophthalmologists who owe their training to him. In 1918, he was married to Hester McNeil Boyd-Carpenter who survives him with two sons and a daughter. He died on April 1st at the age of 82 years.

Phillips Thygeson.

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## JOSEPH IRVING PASCAL
## (1890-1955)

On awarding Pascal honorary membership in the Reading Eye, Ear, Nose, and Throat Society, Dr. Paul C. Craig wrote: "We want to thank you for coming to Reading and letting us get a glimpse of a truly great ophthalmologist, of a man who has grasped the concept of science as a whole, and of his own specialty as an integrated part of the universe."

Many former patients, learning of his demise, conveyed their sympathy. One wrote: "I have long forgotten the ills that first caused me to consult Dr. Pascal but I will always have fond memories of the friendly, thoughtful, and humane manner with which he treated my family, my friends, and myself."

A few years ago Pascal established a center for the rehabilitation of the partially seeing at the New York Polyclinic Hospital and Medical School. His concern extended to guiding the handicapped to sources of employment. One grateful woman said, "I tell my friends about Dr. Pascal, and they just can't believe there is such a man."

Pascal, a native of Lithuania and the son

of a rabbi, was born March 28, 1890, and came to this country in 1901 at the age of 11 years. His academic education was received at Columbia University (B.S., 1912; M.A., 1927), and in 1914 he was graduated from the Rochester School of Optometry. His medical studies, begun at Columbia University (1916-19), were finally completed at the University of Vienna (1930) and followed by a residency in the eye clinics of the Allgemeines Krankenhaus. He returned to Boston, the home of his wife—whom he had married in 1928—and while there headed the refraction department of Beth Israel Hospital. In 1933 he moved to New York City where he became associated for a time with the eye departments of the Hospital for Joint Diseases, Beth David Hospital, and the Harlem Eye and Ear Hospital. At the time of his death he was director of the eye department, Stuyvesant Polyclinic, and connected with the New York Polyclinic Medical School and Hospital, the Brooklyn Eye and Ear Hospital, and the Montefiore Hospital. He was a member of the New York Academy of Medicine, New York Society for Clinical Ophthalmology, Pan-American Association of Ophthalmology, and the American Association for the Advancement of Science.

JOSEPH IRVING PASCAL

Throughout his career Pascal's predominant interest was ophthalmic optics. Versed in English, German, French, Spanish, and Italian, he contributed some 250 articles to journals in all these languages, and abstracted for THE JOURNAL, *Ophthalmic Literature*, and other publications. His first article in THE JOURNAL in 1926 was followed by one or more almost every year since. Of his first book, *Modern Retinoscopy* (1930), now out of print, Edward Jackson said in his review: "We have here the best account of cylinder-retinoscopy that has appeared in English." His second and more definitive work, *Studies in Visual Optics* (1952), gives a clear original presentation of fundamentals and of the author's major contributions. His numerous inventions include the statoscope, a fixation aid in retinoscopy; charts for facilitating accommodation-convergence balance after correction of ametropia; a perimeter-campimeter, presented at the 1941 A.M.A. convention; and a simplification of Raubitscheck's astigmometer, exhibited at the International Congress of Ophthalmology in 1954. During the late war Pascal served as lecturer in physiologic optics for the U. S. Office of Education; partly because of his recommendations the visual requirements for the Air Corps were somewhat simplified. Certain proposals of his for standardizing the nomenclature of ophthalmic optics were accepted by the American Committee on Optics and Visual Physiology.

Pascal loved teaching and had the gift of making the most complicated subjects extraordinarily clear. He was also fond of travel and lectured on physiologic optics in England, France, Switzerland, Mexico, and South America. His uniquely personal but thoroughly orthodox approach was based on the teachings of the acknowledged masters—

Donders, Javal, Tscherning, Maddox, and Edward Jackson; but he was still keenly aware of how much yet remained unknown. His enthusiastic interest never slackened: a few months before his death he accepted the chairmanship of the Committee on Physiologic Optics for the Pan-American Association of Ophthalmology; scheduled a course for the American Academy of Ophthalmology and Otolaryngology on "The method of concordance in the diagnosis of strabismus"; and was preparing an exhibit on "The corneal and retinal meridians in true and false torsion," for the A.M.A. convention of 1955, which was completed and presented by Dr. Arthur Linksz.

Pascal had also broad cultural interests. He had been a violinist in the college orchestra. His poem, "The Patient in Ward 26," won an award from the American Physicians Literary Guild. He had too a tremendous store of kindness and was ever helpful to the refugees from the Hitler regime. In his wife, Charlotte, he found a true helpmate; a former school teacher, she kept his bibliographic files, aided his literary research, and typed his books and manuscripts. Pascal was much upset by the efforts of optometrists to infringe upon or limit the prerogatives of ophthalmologists and optical dispensers and talked privately with optometric leaders about their folly in these directions.

Pascal passed away in New York City after a short illness on April 22, 1955, at the age of 65 years. He was a man apart—dedicated to ophthalmic optics.

James E. Lebensohn.

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## CORRESPONDENCE

### Ophthalmology in Pakistan

Editor:
American Journal of Ophthalmology:

While taking the Harvard course in ophthalmology recently, I became acquainted with Dr. Norval Christy who, eight years ago as a native American and a Harvard graduate, chose to become a missionary doctor in Pakistan.

I do not know of another person in the medical profession who has given himself to such a worthy cause. He performs as many as 50 cataract operations daily with only obsolete equipment, poor instruments, and without the benefit of a slitlamp. Dr. Christy averages approximately 16 working hours daily. His missionary church on limited funds maintains a hospital for his use, each patient bringing his own bed roll and remaining there during his convalescence for something like a total charge of 75 cents, whether the stay is for a period of five days or a month.

His generous effort to bring medical aid to a people who have not the barest essentials for existence has prompted me to ask the help of some ophthalmologists here in this land of plenty. I am mailing a hundred copies of this letter to various men asking each to contribute five or 10 dollars for a good slitlamp and a few good eye instruments. If you have any good usable surgical instruments, cataract knives, and so forth, which you don't need send them along and I'll ship them.

At less than the cost of a refraction, we will derive a great satisfaction from helping in our small way. Would you join me in the project and then hand this letter to a friend?

Funds mailed to me will go directly for the purchase of the needed material and I shall inform you later as to the progress of our worthy mission.

(Signed)
George S. Morrison, M.D.
113 South Kentucky Avenue
Roswell, New Mexico

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# BOOK REVIEWS

TRANSACTIONS OF THE AMERICAN OPHTHALMOLOGY SOCIETY. Volume 52, 1954. New York, Columbia University Press, 1955. 952 pages, index. Price: $18.00.

The *Transactions* of the A.O.S. have been increasing in size since the war and the current issue, which has 50 more pages than that preceding, is the largest in the society's long history even though the customary obituary notices of deceased members have been regrettably omitted. The minutes include an interesting report from the American Board of Ophthalmology. In 1954 multiple-choice questions were introduced for all subjects in the written qualifying test. Of 291 candidates, 229 passed, 16 failed, and 46 were conditioned.

The theses of the seven new associate members, printed though not read, occupy nearly half the volume. Of monographic scope are those submitted by Roper on suture techniques in cataract surgery (164 pages, 56 illustrations, 548 references); by Linksz on the horopter (72 pages); by Elliot on Eales' disease (66 pages); by McCulloch on the zonule of Zinn (62 pages); and by Chamberlain on lateral motility (60 pages).

The contributions and discussions, all of exceptional distinction, are replete with diagnostic and therapeutic advances.

Berens warns that Moore's lightning streaks though occasionally innocuous are more often early signs of inflammatory processes, tumors, detachment, or hemorrhage.

Harrington and Hoyt find in the pure blue obtainable by ultraviolet radiation on luminescent test objects a delicate test for central scotoma which also differentiates the retrobulbar type from that due to macular disease.

Thygeson and Vaughan find selenium sulfide (selsun) the most effective preparation for seborrheic blepharitis but restrict its use to the office.

Kronfeld concludes from his tonographic and fluorometric studies that the final results of cyclodialysis are less controllable than that of any other glaucoma operation.

Greear advocates a simple method of treating hemifacial spasm. Procaine is first used as in O'Brien akinesia but one cm. posteriorly. After five minutes, 95-percent alcohol (two cc.) is injected through the same needle. Relief may last six to eight months.

This stimulating volume will benefit every ophthalmologist. Copies, while still available, may be ordered from one's bookstore or the publishers.

James E. Lebensohn.

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A SURVEY OF COLLEGE HEALTH PROGRAMS FOR PROSPECTIVE TEACHERS: WITH SPECIAL REFERENCE TO EYE HEALTH. By Marjorie A. C. Young, M.Ed., M.P.H., New York, National Society for the Prevention of Blindness, 1954. Paperbound, 131 pages. Price: $1.00.

This analysis of the health programs of 40 colleges approved by the American Association of Colleges for Teacher Education reveals that the standards of the Eye Health Committee of American Colleges are honored more in the breach than in observance. Just 19 colleges required a visual test on entrance, and in only nine was the examination repeated annually though a recent survey indicates that 21 percent of students sustain a decrease in unaided acuity during the college years. In 18 colleges the test charts were not illuminated, in 15 the charts were soiled, wrinkled, or yellowed, and in seven the chart was placed alongside a window.

Only a small percentage of classrooms, laboratories, and libraries met accepted illumination standards. In 28 colleges prospective teachers were not given any experience in the vision screening of children in spite of the established fact that over 27 percent of elementary school children have defective vision.

To inquiries as to what was being taught about visual health one response was: "Eyes

are something that you are born with and there isn't anything you can do about them." Oh, that all college administrators will read this devastating report!

James E. Lebensohn.

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REACTIONS WITH DRUG THERAPY. By Harry L. Alexander. Philadelphia, W. B. Saunders Company, 1955. 301 pages, 33 figures, reference, index. Price: $7.50.

The author is emeritus Professor of Clinical Medicine, Washington University Medical School, and the former editor of the *Journal of Allergy*, who has written a most timely work. The use of various drugs has been enormously increased in the last 25 years as new agents of great value have come into the field. However, each of these drugs is capable of producing a variety of reactions, some of which have resulted in fatalities and other disasters of less serious import. Most every drug has, in addition, side-effects, and hypersensitivity is only one phase of the subject. Even side-reactions caused by antihistamine drugs have created difficult problems. The book covers the subject exceedingly well and is highly recommended to ophthalmologists who have encountered not only local reactions to the drugs in their medicine bag but also occasionally serious systemic conditions as the result of their use of drugs of all kinds.

Derrick Vail.

EMBRYOLOGY OF THE HUMAN EYE. By Aeleta Nichols Barber, Ph.D. St. Louis, Missouri, C. V. Mosby, 1955. 231 pages, 193 illustrations and figures, glossary, index. Price: $8.75.

The author is Associate Professor of Pathology at the Louisiana State University School of Medicine in New Orleans, and the book consists of material and notes that have been used by her in teaching embryology of the eye for over a decade. The illustrations are very well done indeed, consisting for the most part of reproductions of sharply focused microphotographs and it is extraordinary how well these photographs bring out the point at issue. This is not a textbook but rather a manual. The didactic form is particularly suitable to the subject and it is obvious that the author is a profound student of the embryology of the human eye. Since it is designed primarily for the student in ophthalmology, it is entirely agreeable not to find the pages cluttered with the names of the workers and the references to their work in the extensive literature. The short glossary that is appended is a desirable feature especially for the beginner. The book is highly recommended as a satisfactory introduction to the subject. So far as can be determined, the information is quite accurate although it is natural that some of the points, for example the development of the zonule, are still controversial.

Derrick Vail.

# ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

## CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

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## 1

### ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Bahr, G. F. **Electron-microscopic studies of the lens capsule of the eye.** Arch. f. Ophth. **155**:635-638, 1954.

Specially prepared capsules of the lenses of rats and mice were studied with the help of an electron microscope. A lamellar structure of the capsule seems to be most probable. Interference phenomena of the electron waves are said to mean that the molecular arrangement within the lamellas is most regular and possibly of crystalline character. (3 figures, 3 references.) Ernst Schmerl.

François, J., and Neetens, A. **Vascularization of the optic pathway—1. Lamina cribrosa and optic nerve.** Brit. J. Ophth. **38**:472-588, Aug., 1954.

The author discusses each published article on the vascularization of the optic pathway in detail and he points out three important findings: 1. the significance of the capillaries of cerebral origin, 2. the possibility of anastomoses in the lamina cribrosa with capillaries from behind, 3. the disagreement on the subject of anastomoses.

The embryology and comparative anatomy are presented in considerable detail. The hyaloid artery, which first feeds the anterior parts of the optic cup and the lens, loses this function in order to take up its definitive work, the supply of the retina by its proximal part. This is true only in the primates and in man. During the development of the fetus, the central retinal artery supplies the retina only; the circle of Zinn and the other arterial branches of the ophthalmic artery supply only the optic nerve, and the various periods at which the different systems develop and reach their particular regions indicate that some of them are entirely excluded from nourishing the optic nerve.

Many branches may contribute to the nourishment of the optic nerve via the network in the pia mater or the intraorbital cerebral vessels. The central retinal artery does not supply the optic nerve, only the retina. Very early in its course the ophthalmic artery gives off a central optic nerve artery, which at various places in the canal or orbita, forms the axial nutritional system of the optic nerve. The arterial circle of Zinn-Haller is built up by the short posterior ciliary arteries. Choroidal vessels run to the optic nervehead. The axial system seems to be designed to feed the macular fibers and to

serve as vasa vasorum for the central retinal artery. Orwyn H. Ellis.

François, J., Rabaey, M., and Vandermeersche, G. **The ultrastructure of ocular tissues: Studies of the crystalline lens with the electron microscope.** Ophthalmologica **129**:36-53, Jan., 1955.

The ultrastructure of the crystalline lens as seen with the electron microscope is described and illustrated by clear electron photomicrographs. (18 figures, 11 references) Peter C. Kronfeld.

Genis Galvez, Jose M. **A contribution to the knowledge of the sympathetic corneal innervation.** Arch. Soc. oftal. hispano-am. **14**:1184-1216, Oct., 1954.

Seventy-two corneas of the cat, dog, ox, and man were used for this study. The staining technique most suitable for demonstrating sympathetic nerve fibers in the microscopic sections is the silver stain of Bielschowsky-Gros, Jabonero and Boeke. In addition the author used the methylene blue stain according to the technique devised by Schabadsch and used by Hillarp. The literature on former studies in this field is reviewed and analyzed, and the author's findings, illustrated with photomicrographs, are reported. His own studies have definitely demonstrated the existence of a rich sympathetic innervational network in the substantia propria of the cornea. The sympathetic nerve structure consists of a network of cords which penetrates the cornea alone or in conjunction with sensory fibers. Fibrils originating from these cords anastomose with each other and lie in intimate relationship with the fixed corneal cells, sometimes being merely in contact with them and at other times penetrating the interior of the cell. The author believes that this nerve-network, which he describes, coincides generally with Boeke's Grundplexus, the protoplasmic fibers of Jabonero, and the preterminal reticulum of Reisser. (28 figures, 26 references) Ray K. Daily.

Mishima, S. **The innervation of rabbit cornea with special reference to the trigeminal nerve.** Acta Soc. Ophth. Japan **59**:201-213, March, 1955.

When the first branch of the fifth nerve is cut, slight erosion results in the cornea even if the cornea is protected. However, a keratitis with ulceration does not result. In such a cornea, regeneration of the epithelium after injury is slightly protracted. (22 figures, 10 references)

Yukihiko Mitsui.

Nover, Arno. **Histologic changes in auto-transplants of tear-gland tissue.** Arch. f. Ophth. **155**:433-456, 1954.

The author used rabbits for his study and transplanted small pieces of tear-gland tissue into the lower lid or subcutaneously into the abdominal wall. At intervals of from one to 42 days the implanted pieces were excised and studied histologically. In early stages it was found that signs of degeneration prevail whereas in late stages regenerative changes become more and more outspoken. New formation of solid ducts becomes noticeable, and is followed by the formation of lumina and alveoli. Mitotic nuclear division appears in the more highly developed glandular end pieces. (8 figures, 1 table, 28 references) Ernst Schmerl.

Rohen, Johannes. **The retinal vascular system of the rabbit.** Ophthalmologica **128**:307-317, Nov., 1954.

This study of the retinal vascular system of the rabbit was made on whole, India ink-injected retinas as well as on retinal sections. The blood vessels were found only in the zone of medullated nerve fibers, that is within a strip of retina measuring 1 to 2 mm. in height and about 15 mm. in width. The vessels formed two systems of capillaries, a typically reticulate one on the inner retinal surface and a rather unusual deeper system in which nonanastomosing capillary loops were the terminal vessels. The vascular apparatus

of the rabbit's retina is radically different from the retinal vascular systems of other mammals and should be considered a somewhat modified system of optic nerve vessels. (5 figures, 29 references)

Peter C. Kronfeld.

Vrabec, F. **The innervation of the trabecular system of the chamber angle.** Ophthalmologica **128**:359-364, Dec., 1954.

With a modified Bielschowsky method, the author made a systematic search for nerve fibers in the corneoscleral and uveal trabeculae of human and animal eyes. A rich network of fibers could be identified with sensory nerve endings between the layers of the trabecular system. The fibers could be traced back to the ciliary body or the supraciliary space. (4 figures, 3 references) Peter C. Kronfeld.

Wexler, D., and Richardson, S. **Paraffin method of embedding ocular specimens for microscopic study.** A.M.A. Arch. Ophth. **53**:365-368, March, 1955.

The advantages and disadvantages of paraffin and celloidin as embedding media for ocular tissue examinations are given. The authors describe their paraffin method of embedding. (2 figures)

R. W. Danielson.

## 2

## GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Cremer, M., and Cremer, M., Jr. **Middlebrook and Dubos hemagglutination reaction in tuberculous diseases of the eye.** Arch. f. Ophth. **155**:485-491, 1954.

110 patients with clinically manifest ocular tuberculosis and without any signs of general tuberculosis were tested. A positive reaction was obtained in 74 percent of all cases. The original paper by Middlebrook and Dubos was published in the J. Immunol. 56:301, 1947. (2 tables, 23 references) Ernst Schmerl.

Fazakas, Alexander. **Mycologic findings in threshers.** Ophthalmologica **128**:163-179, Sept., 1954.

The author, noted for previous work in ocular mycology, was asked by an agency of the State of Hungary concerned with industrial and farm workers' health problems to make a special study of a form of conjunctivitis which is common in harvesting teams and particularly in threshers in present-day Hungary. A positive culture for fungi was obtained from the conjunctival sac of 80 percent of a large group of threshers. In most instances the specific fungus could be identified. A large number of these fungi had never before been cultured from human eyes. From his personal contact with the workers and the machines they were using, the author was able to make a number of suggestions concerning methods of preventing the settling of fungi in the conjunctival sac. (20 references)

Peter C. Kronfeld.

Nakajima, N. **Experimental studies of non-tuberculous inflammation of the optic nerve and opto-chiasmatic arachnoid in tuberculo-allergic animals. II.** Acta Soc. Ophth. Japan **59**:344-357, April, 1955.

Rabbits were sensitized with B.C.G. When the tuberculin reaction turned positive, either living or heat-killed staphylococcus was introduced into the carotid artery. The animals were killed from two to 165 days thereafter for histopathologic examination. An opticochiasmatic arachnoiditis and retrobulbar neuritis were demonstrated in most animals, even in those which were killed five months after the staphylococcus injection. In those which were killed within 10 days after the injection, a slight choroiditis was also recognizable at the posterior pole of the eye. The changes were apt to be more pronounced in animals injected with living organisms. Cultures from

blood were, however, all negative. Inflammations were negligible when staphylococcus was introduced into non-sensitized animals. Nakajima considers the inflammation to be a parallergic reaction. (12 figures, 1 table, 8 references)

Yukihiko Mitsui.

## 3

### VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Auricchio, Giacinto. **The physiology of endoocular fluids.** Gior. ital. oftal. **8**:103-112, March-April, 1955.

The intraocular fluids are hypertonic with respect to blood plasma, and this is due mainly to the presence of bicarbonates in greater quantity. The author, in his study of this datum, found that: 1. the vitreous contains less bicarbonate than the aqueous but more than the plasma. 2. newly-formed aqueous contains less bicarbonate than normal but always more than the plasma. 3. the bicarbonate content of the aqueous is related to the bicarbonate content of the plasma, and 4. attempts to modify, by means of drugs, the "secretion" of bicarbonates by the ciliary body gave no conclusive result. (5 tables, 15 references) V. Tabone.

Cucco, Giovanni. **The pharmacodynamic mechanism of "vaso-active" drugs on the peripheral circulation. Experimental studies of the blood-aqueous barrier and clinical and therapeutic conclusions.** Ann. di ottal. **81**:63-78, Feb., 1955.

A new vasodilator, C. 1753, which is a combination of nicotinic acid and diphenylethan, was studied. Comparing its action on the permeability of the blood-aqueous barrier with that of nicotinic acid alone demonstrated that the "capillary vaso-activity" of the complex molecule of C. 1753 is more marked than a simple summation would lead to expect. This proves that a true synergism exists between the two components of the new drug. (6 figures, 18 references)

John J. Stern.

Gemolotto, Guglielmo. **Electrophoretic analysis of the protein content of the blood serum in some eye affections. II. Glaucoma.** Ann. di. ottal. **81**:35-40, Jan., 1955.

Electrophoretic analysis of the serum of 15 patients with chronic noncongestive glaucoma showed a decrease of the serum albumin and an increase of gamma globulin. (44 references) John J. Stern.

Gemolotto, G., and Patrone, C. **Mucopolysaccharides in human cornea and sclera in different age groups.** Gior. ital. oftal. **8**:42-52, Jan.-Feb., 1955.

The various techniques for the determination of mucopolysaccharides are described, and the authors give their results of the estimation of this substance in the human cornea and sclera at different ages. They found that mucopolysaccharides were present in greatest amount in persons between the ages of 20 and 40 years. (6 figures, 27 references) V. Tabone.

Kawashima, K. **Developmental mechanism of corneal pulse wave.** Acta Soc. Ophth. Japan **59**:326-329, April, 1955.

According to Kawashima's experiment there are two portions in the corneal pulse wave: a higher-frequency and a lower-frequency portion. When one branch of the central retinal artery is obliterated in rabbits by an intraocular electrocoagulation, a considerable flattening of the corneal pulse wave occurs, particularly of the higher-frequency portion. When both branches are obliterated, the flattening becomes doubled. The author believes that the higher-frequency portion of the corneal pulse wave is due to the pulsation of the retinal artery and that this is the main portion of the wave. A lower-frequency portion, which is merely supple-

mentary, may be due to the pulsation of the ciliary arteries. (2 figures, 3 tables, 7 references) Yukihiko Mitsui.

Keeney, A. H., and Barlow, F. D. **Supplemental testosterone and estrone in alloxan diabetes of the rat.** A.M.A. Arch. Ophth. **53**:407-410, March, 1955.

Of 200 alloxanized albino rats, 117 died during the first week after the injection. Of the survivors, 78 percent became diabetic and 94 percent of these remained so during the remainder of their life. No significant differences could be found in the incidence or severity of retinal changes in alloxan diabetic rats used as controls or in those which were given supplemental estrone or testosterone. (10 references) R. W. Danielson.

Kinsey, V. E., and Palm, E. **Posterior and anterior chamber aqueous humor formation.** A.M.A. Arch. Ophth. **53**:330-344, March, 1955.

The authors discuss the formation of the aqueous humor and describe their experiments on the rate of accumulation of ions in the aqueous humor in the posterior and anterior chamber after the intraperitoneal injection of sodium thiocyanate and radioactive sodium in the form of isotonic sodium bicarbonate. The investigation deals with the following three aspects of the problem of aqueous humor dynamics: 1. the portion of the total amount of the several anions which enters by flow from the posterior chamber and that which enters by diffusion directly from the blood; 2. the rate of flow of aqueous humor, and 3. the possible process of entrance of anions and cations into the posterior chamber.

The authors conclude that the rate of flow out of the anterior chamber is between 1.7 and 2 percent per minute of the volume of the anterior chamber. About half of the thiocyanate and 43 percent of the sodium were found to enter the anterior chamber by diffusion, the remainder from the posterior chamber. Similar computations were made for urea and for a number of negatively charged constituents of the aqueous humor and it was found that approximately half of the total amount of each ion enters by diffusion and half by flow. (5 figures, 3 tables, 26 references) R. W. Danielson.

Komi, T. **Ocular changes in rabbits caused by repeated intravenous injection of adrenaline.** Acta Soc. Ophth. Japan **59**: 313-315, April, 1955.

When adrenaline is repeatedly injected into rabbits intravenously, opacity of the cornea and hyperemia and hemorrhage in the uvea and conjunctiva develop. The corneal opacity occurs earlier in summer (in two to five days) and later in winter (after two weeks). The opacity can be relieved by the administration of an antihistaminic agent. When the agent is withdrawn, however, there is a reappearance of the opacity. The hemorrhage in the choroid is sometimes explosive. The hemorrhage was observed in every animal from 5 to 12 days after the injection of adrenaline. Atropine is ineffective in the prevention of the hemorrhage. (8 figures) Yukihiko Mitsui.

Lincoff, Milton H. **Quinine amblyopia.** A.M.A. Arch. Ophth. **53**:382-384, March, 1955.

Quinine amblyopia occurred in a 48-year-old man who had received only 0.8 gm. of oral quinine in two days. Corticotropin and other drugs were used. The result after a few months was 20/20 corrected vision in each eye, markedly reduced fields, and waxy discs. (3 figures) R. W. Danielson.

Pau, H. **Local application of the sympatholytic drug Opilon.** Klin. Monatsbl. f. Augenh. **126**: 171-176, 1955.

Opilon is a synthetic sympatholytic

drug which can be instilled in a 0.1 to 5 percent solution. The drops of higher concentration are quite irritating and cause an acute conjunctival hyperemia. All concentrations cause a marked miosis which lasts for several hours. The drug does not influence the ciliary muscle. The intraocular pressure can be temporarily decreased in some forms of glaucoma. (3 figures, 23 references)

Frederick C. Blodi.

Popp, Claus. **Corneal erosions with polyethylene—glycolether.** Monatsbl. f. Augenh. **126**: 176-180, 1955.

Seventeen patients suddenly developed a large corneal erosion after an acute ocular infection of some kind and the lesion could be reasonably ascribed to the administration of an ointment which contained the above glycolether as a topical anesthetic. In some experiments it could be shown that the intact rabbit's cornea remains relatively immune to this ether. However, a small epithelial defect will develop into an extensive loss of epithelium if the ointment is applied. It is assumed that this ether is toxic for the corneal epithelium. (1 table, 9 references)

Frederick C. Blodi.

Sbordone G. **Cataract after anti-glaucomatous operations.** Gior. ital. oftal. **7**: 498-505, Nov.-Dec., 1954.

The author found that in rabbits there was a greater concentration of proteins in the aqueous after iridectomy. This was probably brought about by capillary dilatation. This change in the physico-chemical balance between the plasma and the aqueous, while being one of the factors causing a lowering of ocular tension, also can bring about cloudiness of the lens. (1 table, 36 references) V. Tabone.

Seki, S. **Studies of the urea content of the aqueous humor. II-VI.** Acta Soc. Ophth. Japan **59**:275-284, and 315-325, March and April, 1955.

The passage of urea from the serum into the aqueous is impeded by a subconjunctival injection of epinephrine but not by pilocarpine and atropine. The urea in the aqueous does not readily move into the serum in the blood stream even when urea-free Ringer's solution is substituted. Urease was not demonstrated in ocular tissues. A lipid membrane can be demonstrated histologically at the posterior surface of the iris and in the ciliary body. (3 figures, 18 tables, 63 references)

Yukihiko Mitsui.

de Simone, Silvio. **Retinal tonoscopy and its relation to ametropias.** Gior. ital. oftal. **8**:127-158, March-April, 1955.

The author reviews the physiology of the retinal circulation, and describes the various ways in which the retinal arterial and venous pressures can be determined. The published data are compared with each other and also with figures obtained by the author; the apparent divergence is explained. The author also studied his data in relation to ametropia and has found that while in moderate degrees of ametropia there was no appreciable variation from normal, in high myopia and to a lesser extent in mixed astigmatism, levels were of a higher order. (2 figures, 1 table, 44 references) V. Tabone.

## 4

## PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Alajmo, Arnaldo. **A study of aniseikonia.** Gior. ital. oftal. **7**:465-475, Nov.-Dec., 1954.

Aniseikonia was studied in 327 subjects by means of the space eikonometer. The author believes that aniseikonia of the order of 1 percent or less is within physiologic limits and gives no symptoms. He found iseikonia or aniseikonia of 1 percent or less in 87 percent of the patients studied, while in the other 13 percent the

defect was present in a more marked degree. He found no correlation between the occurrence of heterophoria and of aniseikonia. This anomaly never interfered with normal binocular vision. (6 tables, 10 references) V. Tabone.

Mosci, Lamberto. **The behavior of vision in anisometropia and the possibility of functional recovery of the more ametropic eye.** Ann. di ottal. **81**:23-34, Jan., 1955.

In 278 patients with anisometropia of various types and degrees it was found that amblyopia is most common in spherical and astigmatic hypermetropia. This is regarded as a phenomenon of active supression and as such amenable to improvement by exercises and training. (27 references) J. J. Stern.

Pascal, Joseph I. **Apparent optical anomaly of corrected aphakia.** Gior. ital. oftal. **8**:10-12, Jan.-Feb., 1955.

The author explains how parallel rays are focussed on the retina in a corrected aphakic eye as well as in an emmetropic eye, in spite of the fact that in the emmetropic eye the dioptric is 58D and in the aphakic eye only 48D. The explanation of this apparent paradox is to be found in the changed position of the second principal point (P 2) after cataract extraction. V. Tabone.

Perez-Bufil, A. **A case of myopia of 33 diopters, in which 0.5 visual acuity without glasses was noted after Fukala's operation.** Arch. Soc. oftal. hispano-am. **14**:1296-1301, Nov., 1954.

The visual acuity in a 22-year-old man was 0.2 with a myopia of 33 diopters in the right eye and 30 diopters in the left eye. Two discissions and two linear extractions of the cortical masses were done on the right eye. In order to avoid postoperative astigmatism, the author incised the cornea in four areas, temporally and up, nasally and up, temporally and down, and nasally and down. The final visual acuity was 0.5 without correction, and satisfactory reading vision.

The author is very enthusiastic about the results of this operation and he believes that the operation is blamed unjustly for the retinal detachments which are reported frequently in such cases. He reports the case of a patient who had one eye operated and 18 years later developed a retinal detachment in the other eye. In patients over 45 years of age the author performs an extracapsular extraction, avoiding all traction on the capsule. Four cases are reported briefly.

Ray K. Daily.

Raubitschek, E. **Once more the subject of false torsion.** Ophthalmologica **128**: 304-306, Nov., 1954.

On reconsideration of the problem with a simple geometric method the author finds that corresponding corneal and retinal meridians undergo false torsion in opposite direction (cfr. Am. J. Ophth. 38:593, 1954). (1 figure)

Peter C. Kronfeld.

Vics, I. Irving. **Progress report of the partially blind.** Am. J. Optometry **32**:192-205, April, 1955.

This is a detailed report of several cases illustrating the psychological effect of telescopic lenses on the partially sighted. The visual acuity continued to improve during the course of a year, so that in some instances ordinary glasses could be used. The process requires much time, and involves interpretation of new visual clues and reinforcement of the intellectual level. In 100 patients, tested in all 680 times, there was no evidence that the age, duration of blindness, or the type of abnormality were significantly related to prognosis. Paul W. Miles.

Young, Francis A. **Myopes versus non-**

**myopes—a comparison.** Am. J. Optometry **32**:180-191, April, 1955.

In Whitman county, Washington, a homogenous population was found all members which have a high income and good dietary habits. A myopic group of 100 boys and 106 girls were compared to a non-myopic group of 230 boys and 197 girls. All of the children were taller, heavier, and more intelligent than the national average. There were no consistent differences in myopic and non-myopic children in the number of times per week that they ate various types of food. When only the higher myopes were compared with higher degrees of hypermetropia, the myopes were found to eat cake more often, eggs and cookies less often. Correlations of myopia with height, weight, interpupillary distance, intelligence, and breadth of face showed these factors to be insignificant. The only positive correlation was that the myopic children spent more time reading than did the non-myopic children. Paul W. Miles.

## 5

## DIAGNOSIS AND THERAPY

Angius, Tullio. **Treatment of eye disease with radio-iodine.** Rassegna ital. d'ottal. **23**:466-473, Nov.-Dec., 1954.

For the most part radio-iodine has been used for its inhibiting effect in ocular disease. The author, however, has used it to stimulate nutritional factors in torpid conditions. To this end, he has used the isotope in solution instilled into the conjunctival fornices. The strength of the solution was 30 microcuries in 10 cc. of isotonic, sterile sodium chloride solution. A discussion of microelectrovolts and other technical details follows. The lesions reported were mostly corneal affections and membraneous conjunctivitis. The results seem to justify further experience with the isotope. (5 references) Eugene M. Blake.

Barraquer, J., and Muinos, A. **Scleral lamellar resection.** Rassegna ital. d'ottal. **23**:474-481, Nov.-Dec., 1954.

The use of scleral resection in three different conditions is discussed: 1. retinal detachment with aphakia, myopia, retraction of vitreous at the orra serrata, after recurrence when classical methods have failed, and in retinal degeneration of the aged; 2. high myopia with chorioretinitis with floating opacities, contraction of the visual field, loss of vision and retinal hemorrhage; and 3. detachment following Fukala's operation to correct astigmatism and in sclero-choroiditis. Here the location of the scleral resection depends upon the topography of the separated retina, the zone of the retina affected and the axis of the astigmatism. (7 figures) Eugene M. Blake.

Beyer, Eva-Maria. **Experiences with the eye tonic "Stulln."** Klin. Monatsbl. f. Augenh. **126**:202-207, 1955.

This tonic contains digitalis, the extract of horse chestnut and saponines. It is given as drops, three times a day. It is supposed to improve the circulation of blood in the ciliary body and to increase the accommodation. The author used it on 78 patients and was favorably impressed. (4 tables, 8 references) Frederick C. Blodi.

Freeman, D., and Fasanella, R. M. **Use of fine alloy steel wire sutures in ophthalmic surgery.** A.M.A. Arch. Ophth. **53**:404-406, March, 1955.

In general surgery it has been found that fine alloy wire sutures produce the least amount of tissue reaction and promote the most rapid healing of wounds. The authors have tried the suture on the eyes of rabbits and man and found minimal irritation of the corneal tissue. However, conjunctival and palpebral discomfort has proved to be a major difficulty. (2 references) R. W. Danielson.

Gifford, Edward S., Jr. **Psychogenic ocular symptoms.** A.M.A. Arch. Ophth. **53**:318-329, March, 1955.

Since physicians may aggravate or ameliorate neurotic tendencies, a knowledge of psychiatric and psychoanalytic theory is of immense value. Equally important is self-knowledge. The doctor-patient relationship is badly strained if the doctor is unaware of, or is unable to analyze and control his own tendencies to impatience, intolerance, contempt, and hostility. It is truly amazing how irrational we all are.

The theorists of the Freudian school have assigned three motives to neurotic behavior which are present in every neurosis: aggression, self-punishment, and self-love or self-glorification. In this paper many examples of these motives taken from the author's practice and the literature are discussed. The physician must bear in mind the exaggerated sensitivity and suggestibility characteristic of neurotic individuals. He should take the patient seriously and make his examination so obviously thorough that his assurances that no serious organic disease is present are as convincing as possible. (51 references) R. W. Danielson.

Keizer, John P. **Notched retractor and speculum blades for ocular surgery.** A.M.A. Arch. Ophth. **53**:411-412, March, 1955.

The author recommends the notching of retractors and speculum blades to increase the safety and effectiveness of these instruments. (2 figures)

R. W. Danielson.

Morgan, Meredith W., Jr. **The reliability of clinical measurements with special reference to distance heterophoria.** Am. J. Optometry **32**:167-179, April, 1955.

Scobee and Green found the standard deviations on repeated tests for distance heterophoria to be ±2.2 prism diopters, ±2.8 prism diopters, and ±1.9 prism diopters for the screen-parallax, the screen-Maddox rod, and the von Graefe methods respectively. Morgan made 100 measurements by the screen-Maddox rod method on one subject and obtained a standard deviation of ±2.2 prism diopters. By use of an improved statistical method involving consistency, Morgan obtained data on 23 optometry students tested weekly for five weeks. Other data were obtained from clinical material, showing a consistent variance of about 2.3 prism diopters.

Paul W. Miles.

Pettinati, Sergio. **X-ray study of the internal orbital borders.** Rassegna ital. d'ottal. **23**:488-492, Nov.-Dec., 1954.

The usual antero-posterior, or occipito-frontal radiograph shows the internal border of the orbit as a slender line which separates the orbit from the ethmoid cells. This represents the phenomenon of supraposition and gives a false impression of conditions. In cases of fracture this may be quite misleading. Making an oblique exposure overcomes these objections and has proved valuable. (2 figures, 13 references) Eugene M. Blake.

Priestley, B. S., and Foree, K. **Clinical significance of some entoptic phenomena.** A.M.A. Arch. Ophth. **53**:390-397, March, 1955.

Scheerer's phenomenon (the visibility of red blood cells circulating in the paramacular region), and Haidinger's brushes, which depend on the integrity of the nerve fibers of Henle's layer for their appearance, are two of the entoptic phenomena which have clinical value. Means of demonstrating the phenomena are described. The normal response in Scheerer's phenomenon is to see 20 to 25 cells with a pulsating motion. Abnormal responses are found where there are arteriosclerotic changes at the posterior pole, in incomplete occlusion of the central reti-

nal artery, in simple glaucoma, and in central angiospastic retinopathy. Haidinger's brushes are also useful in detecting diseases at the macula lutea, but this is not as reliable and sensitive as Scheerer's phenomenon. The value of both is enhanced by the fact that entoptic phenomena always appear before definite ophthalmoscopic evidence can be noted. Five patients are described. (7 figures, 1 table, 19 references) R. W. Danielson.

Rizzini, Vittorio. **Ircodin—a new analgesic in ophthalmology.** Gior. ital. oftal. **8**:62-65, Jan.-Feb., 1955.

The author has had gratifying results with a new preparation, ircodin (irgapyrin, codeine and medomine), in several inflammatory and painful diseases of the eye; he has also found it of value in the postoperative management of patients to relieve pain after the effect of a local anesthetic has worn off. (8 references) V. Tabone.

Saunders, L. Z., and Smith, R. F. **Fundus photography in color with zirconium arc lamp as light source.** A.M.A. Arch. Ophth. **53**:429-431, March, 1955.

The authors have adapted a zirconium concentrated arc lamp to the Bausch and Lomb retinal camera. The advantages over carbon are that the lamp is silent, is comparatively cool, and gives a uniform brightness and color temperature. A method of installation is discussed. (4 figures, 6 references) R. W. Danielson.

Schmidt, Theo. **Visual field examinations with the Goldmann-perimeter.** Klin. Monatsbl. f. Augenh. **126**:209-217, 1955.

The instrument is briefly described. It is a projection perimeter in which the targets are projected on an illuminated sphere. The light should occasionally be tested with a light meter. The better eye should be tested first. The width of the pupil can be measured with a built-in telescope with which one can also watch the fixation of the patient. The correcting glasses should be worn. (9 figures, 8 references) Frederick C. Blodi.

Tennebaum, Albert E. **Intraocular metallic foreign bodies following cataract extraction.** A.M.A. Arch. Ophth. **53**:432-433, March, 1955.

In seven patients flecks of gold were found in the anterior segments of eyes from which cataracts had been removed by means of a gold-plated erisophake. Reactions occurred in four. Stainless steel instruments should be used. (2 figures) R. W. Danielson.

Wolfson, W. Q., Quinn, J. R., and Spearman, W. F. **Corticoid therapy in eye diseases: sustained restoration of vision in certain eye diseases considered corticoid-refractory or clinically irreversible.** Arch. Int. Med. **95**:400-410, March, 1955.

The authors maintain that not only in certain acute disorders of the eye (e.g. acute retrobulbar neuritis, acute central angiospastic retinopathy) which frequently respond unpredictably to hormonal therapy, but even in certain generally unresponsive inflammatory and degenerative disorders of the eye (e.g. retinitis pigmentosa, Lebor's hereditary optic atrophy, disciform macular degeneration, Coats' disease) intensive individualized long-term corticotropin therapy has permitted a majority of patients to regain normal or useful vision and in almost all cases to maintain their full improvement indefinitely thereafter. (7 figures, 5 references) William C. Caccamise.

## 7

## CONJUNCTIVA, CORNEA, SCLERA

Andreani, D. **A case of tuberculoma of the sclera.** Gior. ital. oftal. **7**:506-516, 1954.

After a review of the literature, a case of tuberculoma of the sclera is described in detail. The tumor was removed and

examined histologically. When its nature became known, medical treatment (streptomycin and isobicin) was instituted with complete recovery. The treatment of this condition is discussed. (3 figures, 52 references) V. Tabone.

di Ferdinando, Renato. **Hereditary crystalline degeneration of the cornea.** Gior. ital. oftal. **7**:476-484, Nov.-Dec., 1954.

A case of hereditary crystalline degeneration of the cornea is described in detail. A boy, aged ten years, showed bilateral symmetrical superficial corneal opacities which, under the microscope, were found to be shining, slightly iridescent, radially disposed groups of needles. In addition, there were medial and lateral paralimbic opacities in an area corresponding to the palpebral aperture. Elsewhere the corneas were clear and the visual acuity was 8/10. The father of this patient also had bilateral corneal opacities, but these were due to primary fatty degeneration of the cornea. The author believes that these two heredo-familial forms of corneal degeneration, although morphologically different, are transmitted by the same gene. (3 figures, 13 references) V. Tabone.

Gualdi, Giovanni. **Cortisone in the treatment of lime burns of the conjunctiva and cornea.** Rassegna ital. d'ottal. **23**:482-487, Nov.-Dec., 1954.

The author obtained good results in lime burns with the following treatment: 1. free irrigation with sweetened water, 2. slitlamp studies of the lesion, 3. nicotinic acid in ointment form, 4. cortisone in 1 percent drops or salve, 5. bandage, 6. 500,000 units of penicillin daily, and 7. vitamin A, given orally. (5 references) Eugene M. Blake.

Moorman, L. T., and Harbert, F. **Treatment of pseudomonas corneal ulcers.** A.M.A. Arch. Ophth. **53**:345-350, March, 1955.

Corneal ulcers due to Pseudomonas aeruginosa usually progress to widespread corneal suppuration, necrosis and perforation within a few days. Prior to the advent of polymyxin it was assumed that the poor results of therapy were due to high resistance to antibiotics. Wiggins has demonstrated that polymyxin B is more effective than aureomycin or streptomycin.

In this article the cases are reviewed which have been reported both before and after the advent of polymyxin and the authors report two cures in eyes treated systematically with polymyxin B. An analysis of 58 cases shows that there has not been an increase in the number of cases in which useful visual acuity has been saved since the advent of topical and subconjunctival polymyxin therapy. The efficacy of treatment in the cases reviewed would seem to depend on early treatment rather than on the type of therapy employed. However, treatment with combined topical and parenteral polymyxin B sulfate therapy in the authors' two cases seen in the early stage of ulceration, resulted in a corrected visual acuity of 6/9. (6 figures, 26 references) R. W. Danielson.

Pautler, E. E., Roberts, R. W., and Beamer, P. R. **Mycotic infection of the eye.** A.M.A. Arch. Ophth. **53**:385-389, March, 1955.

This paper is written to present the clinical and pathological observations in a patient with corneal ulcer and hypopyon, in which Monosporium apiospermum was cultured from the lesion and fungi were demonstrated in histological sections of the eye. This is believed to be the first reported case. Sulfonamide drugs and antibiotics were not effective in controlling the infection. (3 figures, 17 references) R. W. Danielson.

Schiff, F. S. **Cystine deposits of cornea and conjunctiva.** A.M.A. Arch. Ophth. **53**: 434-436, March, 1955.

Cystinosis is a rare metabolic disease of children in which renal rickets, dwarfism, acidosis, hypophosphatemia and renal glycosuria are commonly found. A case of ocular cystinosis in a boy, two and one-half years of age, is reported. The nature of the conjunctival crystalline deposits was established by chromatographic analysis. (3 figures, 7 references)

R. W. Danielson.

Trueb, C. L. Paul. **The distribution of epidemic keratoconjunctivitis in Düsseldorf.** Klin. Monatsbl. f. Augenh. **126**:180-202, 1955.

This highly industrialized area in West Germany (population: 4.8 million) experienced another wave of this virus disease. Between 1952 and 1954 13,465 patients were affected; 62 percent of them were men. Most cases occurred in large plants. Occasionally animals were affected. The disease was milder and its course was shorter than in previous epidemics. Intraocular complications were rare. (2 figures, 6 tables, 64 references)

Frederick C. Blodi.

## 8

### UVEA, SYMPATHETIC DISEASE, AQUEOUS

Calhoun, F. Phinizy, Jr. **Diseases of the uveal tract.** A.M.A. Arch. Ophth. **53**: 437-455, March, 1955.

This annual review covers the period from October, 1953 to October, 1954. (165 references) R. W. Danielson.

Calhoun, F. Phinizy, Jr. **Uveitis as a medical problem.** Postgrad. Med. **17**:245-250, April, 1955.

In this Schneider Foundation Eye Presentation the author succinctly presents basic information concerning various forms of uveitis. The reading of this article is particularly recommended to non-ophthalmologists who wish to be familiarized with a subject that all too often taxes the ophthalmologist. (14 references)

William C. Caccamise.

Funder, Wolfgang. **Iris pigment cysts after mintacol.** Klin. Monatsbl. f. Augenh. **126**:218-219, 1955.

A 72-year-old man developed iris cysts after using mintacol for six months. The vision decreased markedly, but the cysts disappeared when the use of the drug was discontinued. These cysts may occur after the use of a number of other miotics and the term "miosis cyst" is suggested. (3 references) Frederick C. Blodi.

Mosci, Lamberto. **A case of Vogt-Koyanagi-Harada disease.** Ann. di ottal. **81**:41-47, Jan., 1955.

A case is reported and the literature is reviewed. An allergic origin is assumed in view of the good result obtained with cortisone as drops, ointment and subconjunctival injection. (22 references)

J. J. Stern.

Scuderi, G., and Bonaccorsi, A. **Post-traumatic peripapillary choroiditis.** Gior. ital. oftal. **8**:89-102, March-April, 1955.

A review of the literature on rupture of the choroid and associated conditions is given, and three cases are presented, showing post-traumatic lacerations round the discs, with various degrees of optic atrophy. The authors believe that in these cases there is no real rupture of the choroid, as not all its layers are broken, but that degenerative and dystrophic changes are consequent to trophic and neurovascular disturbances. The pathogenesis of the condition is discussed, and the view is expressed, that the trauma causes first a vasoconstriction, then a vasodilatation which is in turn followed by edema and sometimes hemorrhage. The anoxia and the trophic disturbances thus produced

may be the causes of the changes seen. (3 figures, 1 table, 20 references)

V. Tabone.

Unger, Hanns-Hellmuth. **Tonsillectomy in chronic uveitis.** Klin. Monatsbl. f. Augenh. **126**:134-139, 1955.

Among 132 patients with uveitis seen at this clinic, 50 had a tonsillectomy. Only three of these showed a definite improvement after the operation. The 82 similar patients not operated on compared favorably with the 50 patients. (23 references)

Frederick C. Blodi.

## 9

## GLAUCOMA AND OCULAR TENSION

Ambrosio, Andrea. **Testicular function in glaucoma.** Gior. ital. oftal. **7**:517-528, Nov.-Dec., 1954.

After a review of the literature on the relationship between the internal secretions and glaucoma, the author records the results of experiments carried out by him on 12 men, between the ages of 38 and 76 years, who had chronic glaucoma. He used the test of gonadotropic stimulation as practiced by Ceresa and Rubino. In nine of the patients such stimulation produced increased urinary output of steroids, but such increase was below the standard required for a positive test; this, in addition to the three negative responses, would seem to indicate that in chronic glaucoma, there is a change of the interstitial tissues of the testicles. Details of the technique used are described. (2 tables, 58 references) V. Tabone.

Casio, Giuseppe. **The value of cyclodiathermy in infantile glaucoma.** Rassegna ital. d'ottal. **23**:445-450, Nov.-Dec., 1954.

The author reviews the various procedures advocated by Weve, Amsler, Vogt and Weekers to reduce ocular tension by means of the effect of diathermy applied over the region of the ciliary body. He then reports upon the results of Vogt's method in eleven cases of juvenile glaucoma. In two cases the pressure was normalized permanently, in nine the pressure was reduced but soon rose again. In four patients of the latter group re-operation gave good results. The author stresses the simplicity and safety of the procedure. (15 references)

Eugene M. Blake.

Chandler, P. A., and Trotter, R. R. **Angle-closure glaucoma. Subacute types.** A.M.A. Arch. Ophth. **53**:305-317, March, 1955.

Subacute angle-closure glaucoma is a form of glaucoma in which the elevation of tension is due solely to closure of the angle, but, in which the entire angle is not closed at one time so that the attacks of elevated tension are not as severe as in acute glaucoma. In the early stages the eye returns completely to normal between attacks. After repeated attacks portions of the angle may remain closed by peripheral anterior synechias or the trabecular meshwork may be damaged. The authors review the literature, discuss a series of cases and describe the technique of peripheral iridectomy.

The characteristics of this type are as follows. The angle is anatomically narrow under the influence of various physiologic factors. There is usually a history of periodic attacks of ocular discomfort, blurred vision, and seeing colored haloes around lights. Attacks are commoner in the winter and in the evenings and are often precipitated by emotional upsets, moving pictures, television and driving at night. The eye is usually white and quiet. Disc changes, if present, tend toward atrophy rather than cupping. The tension may be normal between attacks. Gonioscopy shows a marked convexity of the iris. Grant is quoted as saying that obstruction to aqueous outflow measured tonographically can be satisfactorily cor-

related with the tension and with the degree of closure of the angle. The provocative tests when positive are of assistance. Treatment is by miotics if efficacious. Otherwise one resorts to peripheral iridectomy except in severe cases where filtering operations are necessary. (5 figures, 15 references) R. W. Danielson.

Chinaglia, V. **Variations of the tension in eye injuries and simple traumatic glaucoma.** Ann. di ottal. **81**:79-103, Feb., 1955.

Taking as point of departure three cases of traumatic hypertension, the author reviews statistically 124 more cases of contusion of the eye. He found that any direct or indirect contusion can cause a disturbance of the ocular tension, and the disturbance need not necessarily be what might be expected from the intensity or the nature of the trauma. The mechanism of simple traumatic hypertension is not yet well understood but the disturbance can be explained by the neuro-vascular theory of Magitot, who postulates a lesion of the intraocular autonomic vasomotor system, accompanied by chemico-physical changes of the intraocular fluid due to a disturbance of the function of the cholinergic and adrenergic fibers. The occurrence of the hypertension is facilitated by the presence of preexisting organic, constitutional or pathologic factors. (43 references)

John J. Stern.

Demers, A., and Monfette, C. **Effect of diamox on ocular tension.** Canad. M.A.J. **72**:529-531, April 1, 1955.

Acute glaucoma is the major indication for the use of diamox, a powerful inhibitor of carbonic anhydrase. It serves well for preoperative medication in primary glaucoma and it reduces the inflammatory reaction in secondary glaucoma. Diamox does not appear to be toxic in doses of 250 mg. twice daily and it may be given for months with only minor side effects. (1 figure, 1 table)

Irwin E. Gaynon.

Nano, H. M., Frigerio, E., and Scenna, M. **Submuscular sclerecto-cyclodialysis in glaucoma.** Arch. oftal. Buenos Aires **29**:497-501, Sept., 1954.

Submuscular slcerecto-cyclodialysis, as described by Malbrán (Malbrán, J.: Am. J. Ophth. 36:365-374, 1954), consists in a scleral trephination—located behind the insertion of the lateral rectus and under its belly—through which an inverse cyclodialysis and an air injection are performed by means of a special canula. After a lavish praise of the excellence of this operation, five cases of ocular hypertension are presented in which the patients were successfully operated upon by this method. One was an uncomplicated case of chronic simple glaucoma and another a common case of chronic, closed-angle type, iris-block glaucoma. In a third patient, secondary glaucoma had developed after repeated corneal transplantation and could not be controlled by an irido-sclerectomy. In a fourth, chronic congestive glaucoma had become manifest after an antiglaucomatous iridectomy and an iridencleisis proved unable to control an acute rise in tension. The last case was one of secondary glaucoma in an aphakic eye; it is noteworthy that in this case an extensive retinal detachment due to an oral disinsertion appeared after the operation only to disappear in an unaccountable way after a few days of rest, much as an ordinary choroidal detachment would have.

A. Urrets-Zavalia, Jr.

Penzani, Bruno. **Heredity of late juvenile glaucoma.** Gior. ital. oftal. **84**:53-61, Jan.-Feb., 1955.

The generally accepted characteristics

of this type of glaucoma are described and the views of distinguished writers on this subject are discussed. A family in which glaucoma was transmitted directly through four generations is described. The disease was manifest in eight subjects and though it appeared after the age of 35 years, it had all the other characteristics of the juvenile type of glaucoma. Study of the relative numbers of healthy and ill members suggests dominant transmission with deficient penetration. (1 figure, 3 tables, 22 references)

V. Tabone.

de Roetth, A., Jr., and Carroll, F. D. **Effect of retrobulbar procaine injection on aqueous humor dynamics.** A.M.A. Arch. Ophth. **53**:399-403, March, 1955.

The authors used Grant's tonographic technique to study the mode of action of the retrobulbar injection of anesthetic agents on the intraocular pressure and other aspects of aqueous humor dynamics.

The most interesting observation was that after the retrobulbar injection of an anesthetic agent there was no change in the facility of aqueous outflow as measured by tonography in open angle glaucoma. The reduction of intraocular pressure seemed to be the result of a simultaneous decrease in the rate of inflow of aqueous. Retrobulbar injection of isotonic salt solution in both normal and glaucomatous eyes had no effect on the tonographic results. (4 tables, 8 references)

R. W. Danielson.

Sbordone, Girolamo. **The effect of iridectomy upon the permeability of the blood aqueous barrier.** Rassegna ital. d'ottal. **23**:451-456, Nov.-Dec., 1954.

Sbordone studied the effect of iridectomy upon the production of aqueous in rabbits. He used the fluorescine test and a Gullstrand nitra lamp. An increase in the permeability of the blood-ophthalmic barrier through modification of the blood circulation by the iridectomy was demonstrated. (1 figure, 8 references)

Eugene M. Blake.

## 10

### CRYSTALLINE LENS

Beretta, Francesco. **The extraction of cataract.** Gior. ital. oftal. **7**:540-547, Nov.-Dec., 1954.

The author discusses various aspects of cataract extraction, particularly the problem of loss of vitreous. He shows how useful his semilunar hook can be for total extraction when the lens capsule ruptures during intracapsular extraction. This hook serves to lift the iris at the 12-o'clock position before delivery of the lens. (4 figures, 14 references) V. Tabone.

Keatinge, G. F., Pearson, J., Simons, J. P., and White, E. E. **Radiation cataract in industry: review of the literature, discussion of the pathogenesis, and description of environmental conditions in an iron rolling mill.** Arch. Indust. Health **11**:305-314, April, 1955.

The literature of radiation cataract as an occupational hazard is briefly reviewed. The diverse theories of pathogenesis are mentioned. An evaluation of the lens findings in 44 workers exposed to the glare of red hot metal in an iron rolling mill is compared with that of a controlled group of 104 patients from a mental institution. Posterior lens changes are not pathognomonic of radiation cataract and may be seen in persons unexposed to a radiation risk. The incidence of posterior capsular and subcapsular changes among those exposed to a high intensity of infrared radiation is very low and that incidence appears to be falling considerably. It is theorized that certain individuals with posterior lens changes may represent cases of hypersensitivity

to the usual non-occupational sources of infrared radiation (e.g. domestic fires). (5 figures, 2 tables, 25 references)

William C. Caccamise.

## 11

### RETINA AND VITREOUS

Fornaro, Luigi. **The treatment of retinitis pigmentosa with ACTH and the melanophore hormone.** Rassegna ital. d'ottal. **23**:457-465, Nov.-Dec., 1954.

The effects of such treatment are indefinite but Fornaro believes that further experience with these products will enable us to evaluate their worth. He predicts that further use of these hormones will justify their role in the unsatisfactory treatment of pigmentary degeneration of the retina. (39 references)

Eugene M. Blake.

Friemann, Werner. **A reaction of the retinal vessels in uveitis.** Klin. Monatsbl. f. Augenh. **126**:129-133, 1955.

In rare cases of uveitis white infiltrates may be observed on the retinal arteries. These are usually only temporary and are explained as an allergic reaction of the arteriolar wall. Previously the term "tuberculous periarteritis nodosa" was coined for this condition. A similar fundus picture was observed in a 21-year-old man. However, in two patients the retinal veins were affected. This is not thought to be a different entity, but the other end of a wide spectrum of vascular reactions in the retina with uveitis. (2 figures, 6 references) Frederick C. Blodi.

Gemolotto, Guglielmo. **The prognosis of idiopathic detachment of the retina in the light of the tendency of spontaneous reattachment prior to surgery.** Ann. di ottal. **81**:51-62, Feb., 1955.

In 280 cases of spontaneous detachment the author found no confirmation of the opinion expressed frequently that a detachment which does not respond to preoperative rest has an absolutely unfavorable surgical prognosis. (37 references)

John J. Stern.

Hummelt, Klaus. **Medical treatment of acute occlusion of retinal arteries.** Klin. Monatsbl. f. Augenh. **126**:142-150, 1955.

The retrobulbar injection of vasodilators is frequently disappointing and this is not surprising as the depot is placed in a fatty tissue with little vascularization and poor provision for resorption. The author has therefore used the intra-arterial injection of priscoline. The administration is percutaneous into the carotid artery. The injection can be repeated. Other vasodilators should be given simultaneously and for a long period. Four patients were treated in this manner with unusual success. (4 figures, 11 references)

Frederick C. Blodi.

Matteucci, Pellegrino. **Observations of macular chorio-retinitis.** Rassegna ital. d'ottal. **23**:437-444, Nov.-Dec., 1954.

The author calls attention to the subjective changes occurring in central chorioretinitis, especially to the evolution of metamorphopsia. The Landolt-Amsler test has furnished precise details of the origin, evolution and healing of the disease. Twelve illustrative cases are described and photographs of the fundus in several are presented. Biomicroscopic examinations show that the disease begins in the choroid and is more or less deep seated. Retinal hemorrhage and edema follow. (10 figures, 7 references)

Eugene M. Blake.

Mueller, Horst. **Clinical and histologic manifestations of retinal arteritis.** Klin. Monatsbl. f. Augenh. **126**:150-154, 1955.

A 31-year-old woman first noted paresthesias and hyperesthesias of the extremities. Soon the pulse was no longer palpable. The erythrocyte sedimentation rate

was increased. There was albuminuria and blood was found in the urine sediment. In each eye a study of the fundus showed sheathing of the vessels and later some exudates and neovascularization. The patient developed hemiplegia, then pneumonia and died.

The autopsy revealed extensive thrombosis of axillary, brachial, vertebral and carotid arteries without any marked inflammatory reaction in the vessel wall. The retinal vessels showed an extensive lymphocytic sheathing with partial obstruction and proliferation. No final diagnosis was made. The possibility of a pulseless disease is unfortunately not discussed. (3 figures) Frederick C. Blodi.

Seidel, J. **Blood examinations in retinal periphlebitis.** Klin. Monatsbl. f. Augenh. **126**:139-142, 1955.

It has been assumed by Donner (Klin. Monatsbl. f. Augenh. 123:112) that patients with retinal periphlebitis have an increased hemoglobin, red blood cell count and prothrombin level. To check this statement 20 patients with retinal periphlebitis were given an extensive hematologic examination and the results were compared with a similar examination of 20 control patients of a similar age. No significant differences were found between the two series. (14 references)

Frederick C. Blodi.

Simonelli, M., and Rizzini, V. **Diathermy in the treatment of recurrent retinal hemorrhages.** Gior. ital. oftal. **8**:1-9, Jan.-Feb., 1955.

After reviewing the work of Verhoeff, Franceschetti and Forni on the subject, the authors describe the favorable results obtained by diathermy coagulation in four cases of recurrent vitreous hemorrhage. Diathermy is applied, in much the same way as for retinal detachment, to the foci of periphlebitis seen by means of the ophthalmoscope. (2 references)

V. Tabone.

## 12

### OPTIC NERVE AND CHIASM

Sutton, P. H., and Beattie, P. H. **Optic atrophy after administration of isoniazid with P.A.S.** Lancet 1:650-651, March 26, 1955.

The authors report a case of optic atrophy beginning ten days after the administration of isoniazid and P.A.S. Inasmuch as the patient had a previous course of P.A.S., and the fact that isoniazid has been a frequent cause of toxic neuritis, it is assumed that isoniazid is the etiologic factor in this case. Irwin E. Gaynon.

## 13

### NEURO-OPHTHALMOLOGY

Cambiaso, Raul Hector. **Unilateral hysterical amaurosis.** Arch. oftal. Buenos Aires **29**:483-494, Sept., 1954.

After a detailed review of the whole subject of hysteria and of its ocular symtomatology, the case of a 15-year-old girl is reported, in which a sudden, total visual loss had been noticed in the left eye, which was known to have had a corrected vision of 20/50. After a conjunctival injection of hypertonic saline was given, the patient could be urged to read 20/400, and two days later, after this first admission of improvement, vision returned to the previous level. (1 table, 43 references) A. Urrets-Zavalía, Jr.

Manzitti, E., and Paris, V. M. **Preretinal hemorrhages in cases of aneurysms of the circle of Willis.** Arch. oftal. Buenos Aires **29**:473-480, Sept., 1954.

As stated by Dandy (Dandy, W. E.: Intracranial Arterial Aneurysms, Comstock, New York, 1945, pp. 15 and 43), "the presence of retinal hemorrhages without papilledema always strongly suggests an aneurysm, although it also occurs with rapidly growing tumors." One type of hemorrhage, the large, round, so-called subhyaloid hemorrhage, is path-

ognomonic of subarachnoidal bleeding and arises in cases of rupture of an aneurysm of the same side of the circle of Willis.

The case of a 12-year-old boy is presented, in which such an ophthalmoscopic picture was detected in the left eye four days after the onset of symptoms of meningeal hemorrhage. Arteriography disclosed an aneurysm of the left middle cerebral artery. Surgical treatment confirmed the preoperative diagnosis and resulted in a permanent cure. (4 figures, 4 references) A. Urrets-Zavalia, Jr.

## 15

### EYELIDS, LACRIMAL APPARATUS

Berke, R. N., and Wadsworth, J. A. C. **Histology of levator muscle in congenital and acquired ptosis.** A.M.A. Arch. Ophth. **53**:413-428, March, 1955.

During the past six years the authors have studied many biopsy specimens of the levator muscle from patients with ptosis. Müller's muscle of the upper lid was always present in acquired and congenital ptosis. Striated muscle fibers of the levator were always found in acquired ptosis, in ptosis due to birth trauma, and in ptosis associated with the jaw-winking phenomenon of Marcus Gunn. Striated muscle fibers were always found in congenital ptosis of 2 mm. or less; never in ptosis of 4 mm. or more.

The number of striated fibers present in congenital ptosis seems to be an important factor in the results from surgery. Congenital ptosis, not associated with birth trauma or jaw-winking phenomenon, is primarily a manifestation of defective structural development of the levator muscle. (29 figures, 8 tables, 23 references) R. W. Danielson.

Brockhurst, Robert J. **Mucocele of the eyelid.** A.M.A. Arch. Ophth. **53**:398, March, 1955.

A mucocele in the lateral portion of the lower eyelid is described. The tumor apparently originated from mucous membrane of the maxillary antrum, which had been displaced at the time of a preceding injury. (1 figure) R. W. Danielson.

Hendrix, J. H., Jr. **Orbicularis muscle strip for correction of ptosis of the eyelid.** Plast. and Reconstruct. Surg. **15**:241-243, March, 1955.

The author presents a case of ptosis in which he used Sarwar's method of dissecting a strip of the upper fibers of the orbicularis oculi muscle and attaching it to the tarsus for elevation. Two incisions are made, one directly above the lashes, the other just below the supraorbital rim. At the site of the upper incision a strip of orbicularis 3 mm. wide is elevated across the middle half of the lid, brought down through a tunnel and a small slit in the superior margin of the tarsal plate, passed back up to the brow, and sutured.

The author states that he has been unable to get as good results with this method in children as he has with teenagers and adults. Drawings and photographs are used to illustrate the procedure. The indications for this procedure in contrast to other ptosis procedures such as levator resection are not included.

Alston Callahan.

Latte, Bachisio. **A cyst of a Meibomian gland.** Gior. ital. oftal. **7**:529-539, Nov.-Dec., 1954.

A case of a cyst of a Meibomian gland of the upper lid is presented. The cyst was removed through the skin. It contained a dense yellowish liquid. No bacteria were seen in this liquid and cultures from it proved negative. Histologic examination revealed metaplasia of the epithelium of the gland. The cyst had never been associated with inflammatory phenomena. The various pathogenetic and diagnostic fea-

tures are discussed. (3 figures, 11 references) V. Tabone.

Pereira, R. F., and Conti, A. **Gangrene of the eyelids in a newborn infant.** Arch. oftal. Buenos Aires **29**:503-510, Sept., 1954.

Noma of the lids is a particularly severe type of moist gangrene which appears for the most part in dystrophic infants and ordinarily proves lethal. The case of a 14-day-old, ill-nourished infant is described in which the condition was fatal in spite of the administration of regular doses of penicillin. (1 figure, 21 references) A. Urrets-Zavalia, Jr.

## 16

### TUMORS

Miani, P., and Alajmo, E. **Primary reticulosarcoma of the orbit.** Gior. ital. oftal. **7**:485-497, Nov.-Dec., 1954.

A case of undifferentiated primary sarcoma of the orbit is described. The tumor appeared on the right side, in a seven-year-old boy. It grew rapidly and the patient died despite treatment (surgery and radium). The possible ways of spread of such tumors are discussed. (10 figures, 4 references) V. Tabone.

## 17

### INJURIES

Byrnes, V. A., Brown, D. V. L., Rose, H. W., and Cibis, P. A. **Chorioretinal burns produced by atomic flash.** A.M.A. Arch. Ophth. **53**:351-364, March, 1955.

Eclipse burns and atomic flash burns are both produced by visible light and by infrared rays. An eclipse burn is incurred through a small pupil and over a longer time, whereas the atomic flash is almost instantaneous and sometimes through a dilated pupil. In the first part of this study the physical factors are considered, in the second the results obtained in an experiment using 700 rabbits in six atomic detonations, and in the third part the pathologic findings.

The work was done with bombs equivalent to 20,000 tons of TNT. Such a bomb produces a fireball of 13,700 mm., 0.1 msec. after explosion. During the first second the fireball grows to about 10 times this radius and it persists for about three seconds after the explosion. At 0.1 msec. the surface temperature is 300,000 K; after 10 msec., it is 2000 K. Closure of the lids in man has a minimum latency of 55 msec.

The typical fresh lesion in the rabbit eye is round and sharp; and, if detonation flash is within eight miles, one sees a deep central hole with glistening white base. All of the eyes were affected at a distance of 27 miles; some rabbits showed lesions at 42 miles. The pathology of the lesions is described.

The clinical observation of a sharply circumscribed coagulated area in the fundus together with the pathologic finding of solid fusion of retina, choroid, and sclera suggests the use of visible and infrared radiations as potential agents in the therapy of such intraocular diseases as retinal detachments, small malignant growths, and retinal cysts. (11 figures, 142 references) R. W. Danielson.

Rizzini, Vittorio. **Cortisone in perforating eye injuries.** Gior. ital. oftal. **8**:121-126, March-April, 1955.

A statistical evaluation was made of the results of therapy with cortisone in 218 cases of perforating injury of the eye. Of these, 102 were treated with antibiotics alone, while 116 were treated with antibiotics plus cortisone, locally. The latter showed an undoubted benefit from the use of cortisone and it was possible to save more eyes, and to maintain or restore a higher acuity of vision in affected eyes. (2 figures, 2 tables, 2 references) V. Tabone.

## 18

### SYSTEMIC DISEASE AND PARASITES

Amendola, F. **Sulfontherapy in ocular leprosy.** Klin. Monatsbl. f. Augenh. **126**: 207-209, 1955.

The author describes the poor prognosis of ocular leprosy before 1949. Ocular complications were frequent and many patients in this Brazilian colony became blind. Since the advent of the sulfones ocular leprosy has practically disappeared. Frederick C. Blodi.

Goslich, H., and Mysius, K. **Ocular symptoms in myopathy.** Klin. Monatsbl. f. Augenh. **126**:165-170, 1955.

A 69-year-old man first noted a paralysis of gaze. Later diplopia developed and weakness of other muscles occurred. The patient was well maintained on anticholinesterase drugs except for one myasthenic crisis with epigastric pain, hypersalivation and collapse. These crises are probably an acetylcholine intoxication. Atropine will help. Frederick C. Blodi.

## 19

### CONGENITAL DEFORMITIES, HEREDITY

Cambiaggi, A. **The association of retinitis pigmentosa and keratoconus.** Gior. ital. oftal. **8**:13-22, Jan.-Feb., 1955.

Four cases of retinitis pigmentosa associated with keratoconus are described; the retinal lesion was present since birth, while the keratoconus became apparent between the tenth and eighteenth year of age. Three of these patients were siblings while the fourth had a sister who also had retinitis pigmentosa. The parents of these four patients were not related. Stress is laid on the hereditary factor in such associated affections and statistical proof of this was obtained by the system of Catsch and confirmed by the use of the coefficient of Yule. These abnormalities have been ascribed to endocrine imbalance and to abnormalities of development. (18 references) V. Tabone.

Capalbi, S., and Binchi, N. **The hereditary transmission of some of the more frequent anomalies of the human eye.** Ann. di ottal. **81**:1-22, Jan., 1955.

The author made a statistical study of the incidence of errors of refraction and concomitant strabismus in 161 members of 41 families. High hypermetropia shows a recessive type of heredity, mild hypermetropia may be of the recessive or the dominant type. Marked differences between the degree of hypermetropia in parents and children suggest the possibility of external factors playing a role. Myopia of any degree is almost always recessive. The difference of degree between parents and children is not marked. Astigmatism seemed to be a recessive error, except in two families where it was dominant. Concomitant strabismus seems to be transmitted as a recessive character and seems to be related to refractive errors. In some families in which retinitis pigmentosa occurred, it seemed that it was not sexlinked. (33 references) John J. Stern.

Dorello, Ugo. **Unilateral ectopia lentis in a case of Marfan's syndrome.** Gior. ital. oftal. **8**:113-120, March-April, 1955.

A patient is described who showed the usual characteristics of Marfan's syndrome, except that the subluxation of the lens was observed on the right side only. The rarity of this finding is stressed. (3 figures, 60 references) V. Tabone.

# NEWS ITEMS

Edited by Donald J. Lyle, M.D.
601 Union Trust Building, Cincinnati 2

News items should reach the editor by the 12th of the month but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received at least three months before the date of occurrence.

## Deaths

Dr. Thomas Collins Austin, Santa Barbara, California, died March 15, 1955, aged 74 years.

Dr. Richard Leslie Bower, Carmel, California, died March 26, 1955, aged 63 years.

Dr. Clyde Alvin Clapp, Baltimore, Maryland, died April 9, 1955, aged 74 years.

Dr. John Edward Gray, Sacramento, California, died April 14, 1955, aged 43 years.

Dr. Walter Robert Parker, Detroit, Michigan, died April 1, 1955, aged 89 years.

Dr. Kaufman Schlivek, New York City, died March 31, 1955, aged 74 years.

Dr. Harry Vernon Thomas, Clarksburg, West Virginia, died April 21, 1955, aged 59 years.

## Appointments

### Graduate Medical School, University of Pennsylvania

The dean of the Graduate School of Medicine of The University of Pennsylvania announces the appointment of Dr. Edmund B. Spaeth, professor of ophthalmology and chairman of the Department of Ophthalmology, as professor emeritus of ophthalmology. The dean also announces the appointment of Dr. Irving H. Leopold as professor of ophthalmology and chairman of the Department of Ophthalmology of the Graduate School, as Dr. Spaeth's successor.

### Harvard Medical School

Harvard Medical School has announced the promotion of Dr. David G. Cogan from associate professor to full professor of ophthalmology, and the promotion of Dr. W. Morton Grant from assistant professor to associate of ophthalmology.

Dr. Cogan will continue his present position as director of the Howe Laboratory of Ophthalmology; Dr. Edwin B. Dunphy will remain as Williams Professor of Ophthalmology and head of the department.

## Miscellaneous

### Research on trachoma

The Arabian American Oil Company announces the undertaking of a five year, $500,000 research program with the Harvard School of Public Health, Boston, on the prevention of trachoma. The Arabian American Oil Company will contribute $100,000 annually and will make available the facilities of its new medical center in Dhahran, Saudi Arabia. A large part of a second floor wing of the Dhahran health center, including three modern laboratories, has been reserved for the project. Harvard University will provide the professional and technical staff for studies in the Middle East and in its laboratories at Boston. The research group will be directed by Dr. John C. Snyder, recently appointed dean of the school of public health.

### Sight-Saving Month

Plans for the fifth annual September, "Sight-Saving Month," campaign to mobilize efforts against the increasing threat of blindness in this country have been announced by Dr. Franklin M. Foote, executive director of the National Society for the Prevention of Blindness.

Blindness in the United States, Dr. Foote reported, has reached the rate of more than 27,000 new cases annually.

## Societies

### Egyptian society

The following officers were elected at the recent annual meeting to form the council of the Ophthalmological Society of Egypt for 1955:

President, Dr. Ismail Disouki; vice-president, Dr. Fattouh Mohammad Fattouh; treasurer and archivist, Dr. Ahmad Adb El Rehim Fahmy; secretary, Dr. Sabri Kamel; assistant secretary, Dr. Mohammad Tawfik Ismail; members, Dr. Zakaria Taher, Dr. Aly Mortada, Dr. Mohammad Azmy Abd El Kadar Khalifa, and Dr. Khalifa Abd El Latif Kamali.

### Biological Photographic Association

The 25th annual convention of the Biological Photographic Association, Inc., will be held at the Hotel Wisconsin, Milwaukee, Wisconsin, August 30 and 31 and September 1 and 2, 1955.

### Oxford Program

At the 50th annual meeting of the Oxford Ophthalmological Society, the following program was presented:

Discussion: "The eye and pituitary hormones," with openers: Dr. Raymond Greene, London; Sir Russell Brain, London; Mr. Joe Pennybacker, Oxford; and Mr. H. B. Stallard, London.

"Modifications to surface diathermy operation," Mr. A. Stanworth, Manchester; "Diastolic retinal pressure: Its value and significance in vascular hypertension," Dr. Henri A. Miller and Dr. E. Audoneineix, Paris; "Diathermy or scleral resec-

tion," Mr. C. Dee Shapland, London: "The cortical and diencephalic regulatory center for glaucoma," Prof. V. Cavka, Sarajevo, Jugoslavia; "Ocular changes in monkeys fed with sanguinarine and other substances," Dr. E. H. Leach and Mr. J. P. F. Lloyd, Oxford.

"The etiology and clinical features of dacryoadenitis," Mr. Barrie R. Jones, London; "Ocular manifestations of general disease: A pictorial survey," Mr. Joseph Minton, London; "Considerations affecting technique and results in keratoplasty: The Doyne Memorial Lecture," Mr. J. W. Tudor Thomas, Cardiff, Wales; "The preservation of eye solutions against contamination of pyocyanea: II. The effect of some preservatives on penicillin solutions," Mr. M. Klein and Mr. E. G. Millwood, London; "Keratoplasty in cases of gross corneal opacification, "Mr. A. G. Leigh, London; "Conservation of the eyeball in the treatment of certain tumors of the orbit," Mr. Harvey Jackson, London; "A comparison of surgical and conservative treatment in simple glaucoma," Mr. T. A. S. Boyd; a film on "Dacryocystorhinostomy," Mr. A. E. P. Parker, Middlesbrough.

Discussion: "Anesthetics and relaxants in ophthalmic surgery," openers: Mr. Nigel Cridland and Dr. H. B. C. Sandiford, Portsmouth, and Mr. A. B. Nutt and Dr. H. L. Wilson, Sheffield; "Experimental exophthalmos in rats due to Thiouracil and cortisone," Dr. Dorothy R. Campbell and E. M. Tonks; "Some cases of paralysis of accommodation," Mr. R. W. Stephenson, Cheltenham.

### Saint Louis Officers

At the annual business meeting of the Saint Louis Ophthalmological Society, the following officers were elected for 1955-56: President, Dr. James H. Bryan, vice-president, Dr. Benjamin Milder; secretary, Dr. Philip T. Shahan; treasurer, Dr. Wilbur H. Lewin; member-at-large, Dr. L. C. Drews.

### São Paulo

Recently elected officers of the Sociedade de Oftalmologia de São Paulo are: President, Dr. Renato de Toledo; vice-president, Dr. Gino L. Barrettini; general secretary, Dr. Armando de A. Novaes; secretary, Dr. Coriolando E. Ponpeu; treasurer, Dr. Jair Ribeiro da Silva; archivist, Dr. Julio Pereira Gomes.

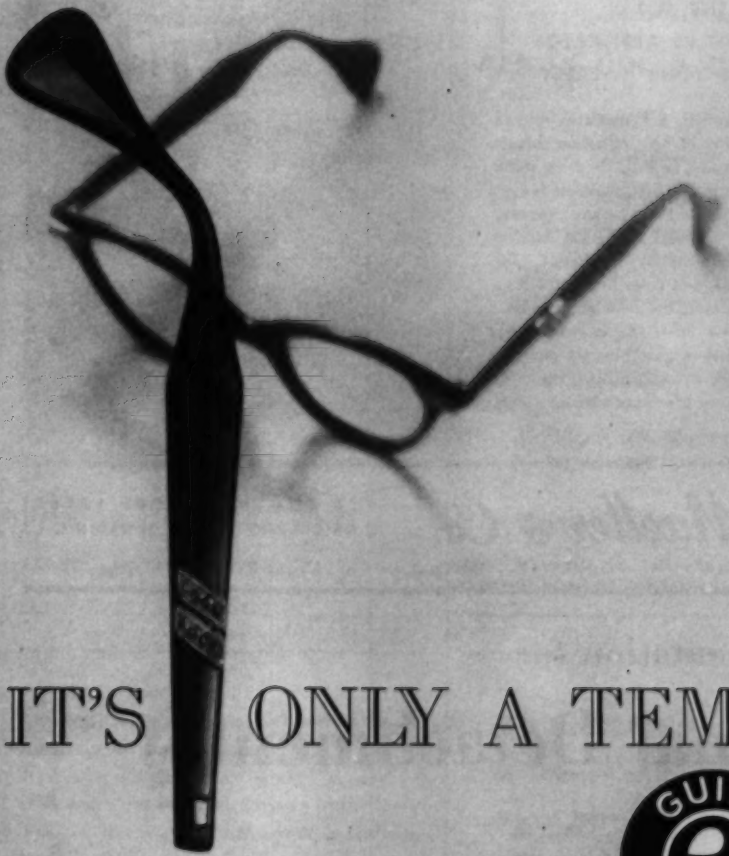
## Ophthalmic Miniature

Moreover, on reading the mass of words on glaucoma appearing in the last twenty years, one concludes that there seems to be considerable misconception regarding nonglaucomatous hypertension, and that, returning to the concepts of 1860-1880, all of the symptoms observed in primary glaucoma are attributed to hardness of the eye. The Anglo-Saxon literature is particularly rich in examples of this kind, which can only be explained by the scorn professed by the Americans for works that are not written in English, perhaps because they are ignorant of other languages, but especially because they have the feeling of world superiority with the conviction that a perfected technic is more important than reasoning and clinical observation.

A. Magitot,

*L'Hypertension oculaire est un symptom et non une maladie,*
*Annals d'oculistique,* 187:1, 1954

(Wow! Ed.)



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| Walker, chuck handle complete with cord | 5.50 |
| Pischel, electrode ½, 1, 1½, 2½mm | 3.50 ea. |
| Pischel, micro-pin introducing forceps | 16.50 |
| Kronfeld, micro-pin introducing forceps | 13.50 |
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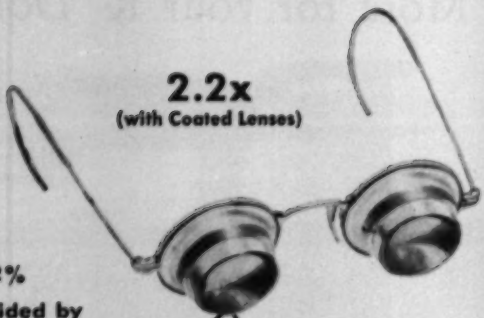


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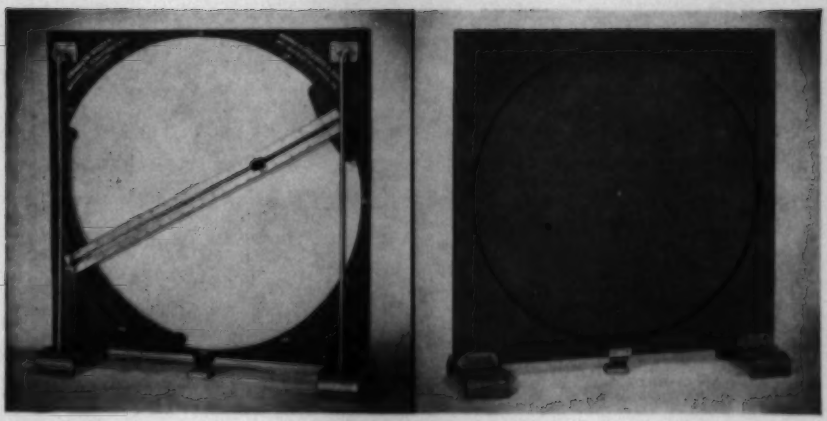

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**DISPENSING SERVICE**

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109 N. Wabash Ave., at Wash.
Chicago, Illinois

Austin Belgard INC.

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**OPHTHALMIC OPTICIANS**
**Wholesale & Service**

Branch Offices:
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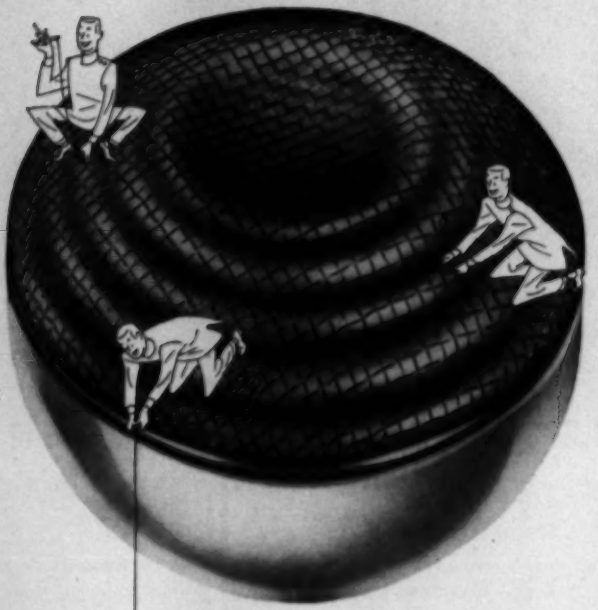
# AO MONOPLEX



**complete**

service--
artificial
eyes and
orbital
implants

Superior artificial eyes and buried implants have long been a distinctive feature of AO Monoplex† service. The completeness and adaptability of the service offered in these two fields is illustrated in the following list of Monoplex products.

- **All-Plastic Artificial Eyes** (stock and modifications)
- **All-Plastic Custom Artificial Eyes**
- **Cosmetic Cover Lenses**
- **Muscle Attached Buried Implants**
- **Conformers for Postoperative Use**

For complete information write Monoplex Department, American Optical Company, Southbridge, Massachusetts.

† T. M. REG. BY AMERICAN OPTICAL COMPANY

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